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THE GETTY CENTER LIBRARY
Why ask for the moon
when we have the stars?
AS

SOME VIEWS OF OUR NEW BUILDING

SCIENTIFIC INSTRUMENT WORKS
of the
L. E. KNOTT APPARATUS CO.

OUR BUILDING IS OF MOST MODERN CONSTRUCTION OF REINFORCED CONCRETE, FIREPROOF, WELL-LIGHTED AND WELL-VENTILATED. IT IS AN IDEAL BUILDING FOR THE MANUFACTURE OF SCIENTIFIC INSTRUMENTS.

L. E. KNOTT APPARATUS COMPANY

CAMBRIDGE STATION A BOSTON, MASS.

OUR LARGE AND WELL-LIGHTED SALESROOM GIVES US AN UNUSUAL OPPORTUNITY TO DISPLAY THE VARIOUS INSTRUMENTS OF OUR MANUFACTURE. THE VIEW ABOVE SHOWS THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY BEYOND.

WE EXTEND TO ALL PERSONS WHO MAY FIND THEMSELVES IN BOSTON OR VICINITY A CORDIAL INVITATION TO VISIT US. WE ARE LOCATED FOUR MINUTES' WALK WEST OF THE KENDALL SQUARE STATION OF THE CAMBRIDGE SUBWAY. (THREE MINUTES FROM PARK STREET.)

SHOWING OUR NEW LOCATION ON THE NORTHERLY SIDE OF THE CHARLES RIVER BASIN BETWEEN THE NEW BUILDINGS OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND THE KENDALL SQUARE STATION OF THE CAMBRIDGE SUBWAY.

L. E. KNOTT APPARATUS COMPANY, BOSTON

A Catalogue

of

Scientific Instruments

Catalogue 21

L. E. Knott Apparatus Company

AMES AND AMHERST STREETS

(Cambridge A Station)

BOSTON

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PREFACE

WE offer in the following pages a series of scientific instruments and a list of physical apparatus which will be found adequate for the study of Physics in the most advanced laboratory. All instructors in science will recall that we are by direct descent the oldest apparatus house in this country, dating back to 1854. We still have with us men who have worked under and were intimately connected with such men as E. S. Ritchie, A. P. Gage, and A. E. Dolbear. Many will recall that it was Mr. E. S. Ritchie whom Professor Tyndall selected to assist him during his American lectures.

The number of this catalogue indicates the number of years that the L. E. Knott Apparatus Company, under its present name, has been in business. During this time it has doubtless equipped more laboratories and furnished more material to colleges and schools than any other house of its line. We therefore feel that we are peculiarly well fitted to offer a catalogue such as this. We ask your consideration of the following pages.

Under each subject we have aimed to include only those pieces best suited for the particular experiment and demonstration. In making this selection from our complete line we have found that it requires even greater judgment to determine what to omit than it does to determine what to include, but unnecessary duplication has been carefully avoided. We realize that the instructor whose duty it is to equip or improve a laboratory should buy only the best and at the same time strive to make his appropriation go as far as possible.

A large proportion of the articles offered have been designed and developed in our own laboratory under the supervision of men whose training and experience have well fitted them for the task. In making the selection we have been guided by numerous suggestions received from our customers, an obligation which we are pleased at this time to acknowledge, with the hope that all of our customers will feel it an obligation as well as a pleasure to favor us with any further suggestions which their experience develops.

Such a complete line of educational instruments as we here list could hardly have been offered at this time had it not been for the greatly improved and well-nigh perfect facilities which our new reinforced concrete building has placed at our disposal. At first the European war caused some forebodings as to its effect on the completeness of our line, but the advantage offered by our new factory has dispelled all fears of this nature.

We wish to emphasize the fact that in the compiling of this catalogue we have endeavored to make it more than a price-list. The arrangement, we believe, will be found to have been made on a scientific basis, each instrument being classified and appearing in its proper place. We have embodied in our descriptions many valuable suggestions concerning the use of the apparatus on the lecture table and in the laboratory. The illustrations are original, prepared from photographs taken from the completed instrument itself.

DIRECTIONS AND TERMS

THIS CATALOGUE SUPERSEDES AND DISPLACES ALL PREVIOUS EDITIONS

CORRESPONDENCE: — Persons writing to us should use an official letter-head whenever possible. If such stationery is not available, kindly advise what institution you are connected with and the position you hold.

ORDERS: — Order blanks will be furnished to prospective buyers upon request. When making out your orders, specify the catalogue number and the edition, with sufficient description to indicate clearly the article desired. This will prevent errors which might occur where the catalogue number alone is given, or where the description alone is given.

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RETURNS: — If for any reason it is desirable to return goods, kindly advise us by mail concerning the conditions so that no misunderstanding may arise. We are always glad to accommodate but we cannot accept or give credit for goods which are returned without previous arrangement having been made.

REPAIRS: — If goods are sent to us for repair, see that the case is properly marked, giving the name of the sender. Send us a letter at the same time stating what you are returning and what you wish to have done to it.

LABORATORY FURNITURE

SINCE 1896 we have maintained a special department for the critical investigation and study of laboratory and lecture-room needs. It has been the duty of this department to design and manufacture both the laboratory and lecture-room tables and the special and distinctive general fittings which are necessary in order to secure the best possible facilities for high-grade science work.

That this service has been appreciated is evidenced by the constantly increasing business which this department has been called upon to handle.

It is a source of great satisfaction to us that architects, school boards and superintendents of schools are more and more availing themselves of the technical experience of this department, appreciating as they do that two decades of constant application to this work have put us in position to render valuable assistance.

On the following pages we list a few of the standard designs which have proven most generally serviceable. These designs will serve to illustrate the high character of our laboratory furniture:

1st. Each piece is designed with a complete knowledge of the conditions under which it is to be used.

2nd. Full consideration has been given to the fact that a laboratory table becomes a permanent part of the building and hence should be as rigid and as substantial as the building itself.

3rd. Material, finish, and workmanship should be of the best, to insure durability equal to the life of the building.

The services of this department are freely offered to those who are planning new laboratories.

STANDARD PHYSICS TABLE

Knott's Special
Three-part Clamp

No. 1-100

1–100 PHYSICS TABLE with **FIXED UPRIGHT** and **ADJUSTABLE CROSS-BAR**. This table has been so extensively used for the last fifteen years that it is considered the Standard Physics Laboratory Table. The body is made of selected kiln-dried ash, oil and wax finish, presenting a handsome finish, accentuating the grain of the wood. The top is built up of selected, straight-grained, kiln-dried strips, machined, matched and joined in such a manner as to prevent warping. It is finished a durable black acid-proof finish. Uprights and cross-bar are of ash, 1½ inches by 3 inches, finished to match body, cross-bar being held by the Knott Special Three-Part Clamp which readily allows adjustment without binding and which will hold the bar firmly in any desired position.

This table is 6 feet long, 4 feet wide and 34 inches high. It is equipped with four drawers, two on each side.

Each, f. o. b. Factory, **$29.75**

We are prepared to furnish tables of any desired finish to match furniture already in the building, and, if the order is sufficiently large, this can be done without extra charge.

PHYSICS TABLE

Clamp and Support

No. 1–120

1–120 PHYSICS TABLE. This table has found considerable favor in Physics Laboratories from the fact that the rods and clamps with which laboratories are so universally equipped may be utilized for the uprights and cross-bar. The detachable feature, leaving clear the whole top of the table, is a distinct advantage.

This table is of the same high quality as No. **1–100.** It is six feet long, four feet wide, thirty-four inches high. It is not provided with drawers, as in laboratories provided with ample storage facilities they may be considered unessential.

With each table accessories for uprights and cross-bar attachments are furnished as follows:

Two **5–1150** "Harcourt" Universal Basic Clamps "B."
Two **5–20e** Threaded Rods, 19 millimeters diameter, for uprights.
Two **5–765** Right Angle V Clamps.
One **5–40c** Support Rod for Cross-Bar, 19 millimeters diameter.

Table complete as above, f. o. b. Factory, **$29.75**

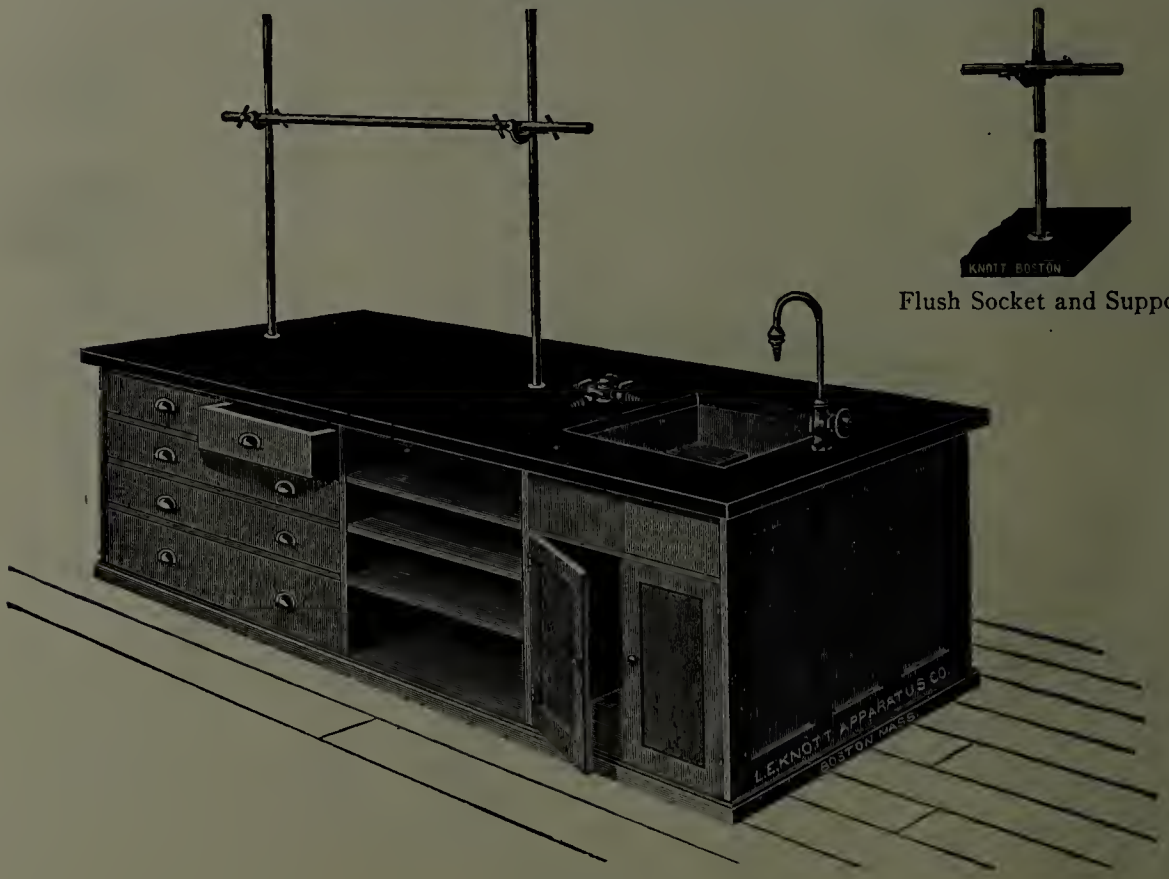
1–125 PHYSICS TABLE,—same table as No. **1–120,** but furnished without uprights and cross-bar, as they are not required where a laboratory already has such an equipment.

Table only, f. o. b Factory, **$21.00**

We are prepared to furnish tables of any desired finish to match furniture already in the building, and, if the order is sufficiently large, this can be done without extra charge.

STANDARD LECTURE TABLE

Flush Socket and Support



No. 1–150

1–150 COMBINATION LECTURE TABLE for either **PHYSICS** or **CHEMISTRY LECTURE ROOM.** This table has the distinctive qualities of all our laboratory furniture. The body is made of selected kiln-dried ash, oil and wax finish. Top is built up from selected narrow, straight-grained, kiln-dried strips, machined, matched and joined in such a manner as to prevent warping. It has a durable black acid-proof finish.

It is furnished equipped with plumbing to the floor line for both gas and water and supplied with the Knott special goose-neck water faucet which carries three attachments,—one for small rubber hose, one for large, and one for attaching an aspirator. It has, in addition, one four-way Knott Turret for gas supply and a Special Gas Cock with lever handle and long serrated ends.

It is equipped, also, with two No. **5–274** nickel-plated Flush Sockets, two No. **5–20e** Support Rods, two No. **5–765** Right Angle Clamps and No. **5–40b** Support Rod for Cross-Bar.

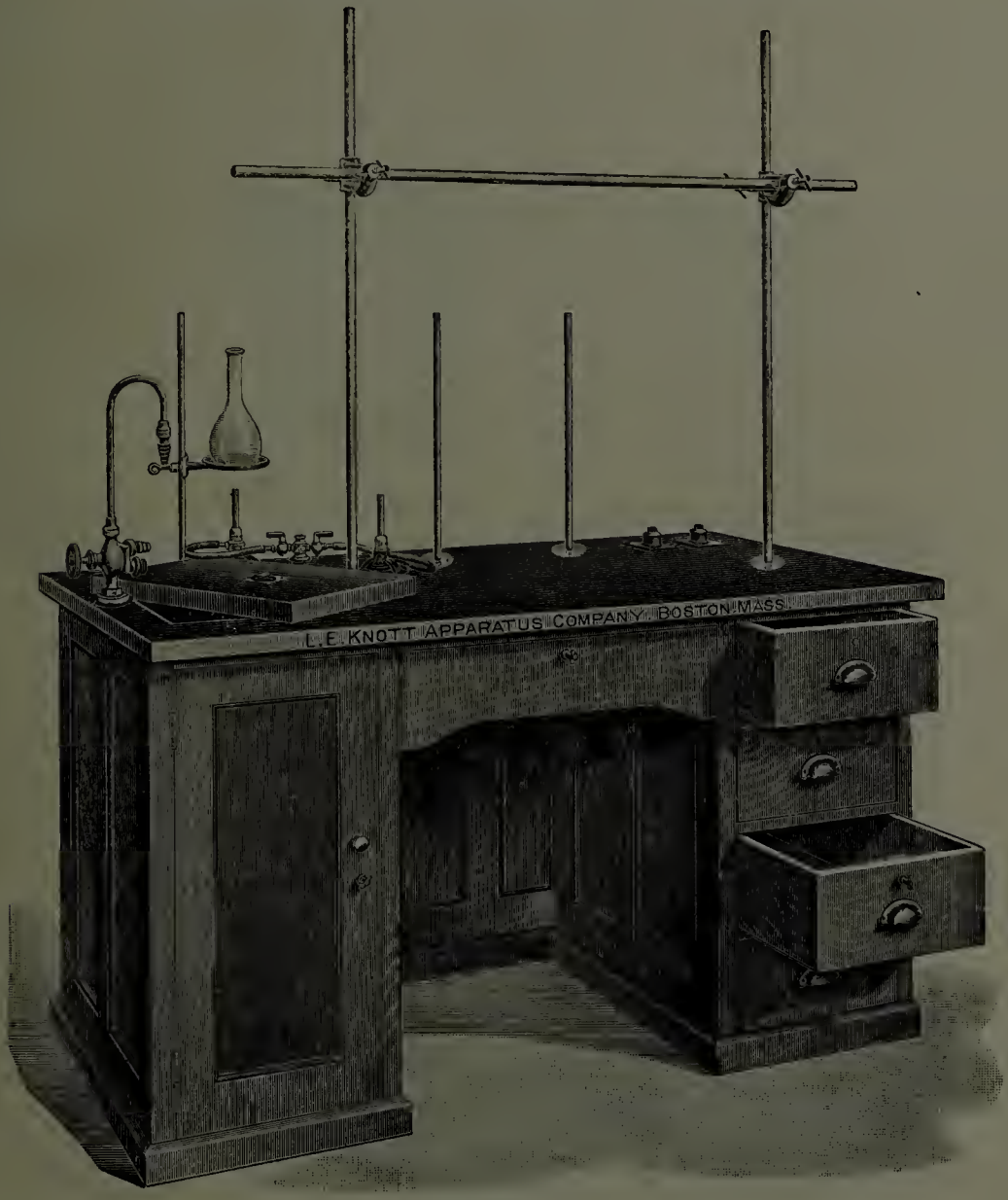
The design of this desk is such as to afford best facilities for Lecture Table Demonstration. Top is supplied with lead-lined pneumatic sink, 18 inches square by 16 inches deep, with a shelf 8 inches wide placed 6 inches from the top. The front and ends are paneled and back is equipped with three large and two small drawers, four open shelves and commodious cupboard.

This table is 8 feet long, 3 feet wide and 34 inches high.

Each, f. o. b. Factory, **$103.00**

We are prepared to furnish tables of any desired finish to match furniture already in the building, and, if the order is sufficiently large, this can be done without extra charge.

INSTRUCTOR'S TABLE



No. 1–200

1–200 INSTRUCTOR'S LABORATORY TABLE for small lecture room. The body of this table is of ash, oil and wax finish. The top is built up from straight-grained, kiln-dried strips with special black acid-proof finish.

It is furnished equipped with plumbing to the floor line for gas and water and supplied with the Knott special goose-neck faucet which carries three attachments, — one for small and one for large rubber tubing connections, and one for attaching an aspirator, a two-way turret for gas connections with a special lever-handle gas cock with long serrated ends. Set into the top of the table is a lead-lined sink, 16 × 10 × 9 inches deep.

The top is further equipped with three No. **5–270** and two No. **5–274** Flush Plates for the three No. **5–10e** and two No. **5–20e** Support Rods, one No. **5–40a** Support Rod for Cross-Bar and two No. **5–765** Right Angle V Clamps. Electrical Connections illustrated are furnished only on application and at an extra charge.

This table is designed to offer the best possible facilities in the smallest space. The front and ends are paneled; the back has five drawers and commodious cupboard space. The table is 5 feet long by 2½ feet wide by 34 feet high.

Each, f. o. b. Factory, **$67.50**

We are prepared to furnish tables of any desired finish to match furniture already in the building, and, if the order is sufficiently large, this can be done without extra charge.

APPARATUS CABINET

An experience extending over two decades has demonstrated positively to us that educational institutions in need of adequate and serviceable storage space for any of the branches of science have felt a far greater satisfaction in purchasing cabinets built especially to fit and meet individual conditions.

We have the best of facilities for building such furniture to order.

LOOSE-LEAF FILING CABINET

No. 1–650

1–650 LOOSE-LEAF CABINET for storing and filing loose-leaf material of all kinds.

This cabinet, originally designed to fulfil the demand for storage and filing facilities for Loose-Leaf Note-Book material, has found a place of equal value in the offices of school superintendents and principals. Its adaptability to the filing of school records for instant reference, is unsurpassed by any system of filing. By opening the two doors, the entire fifty-six compartments, all legibly numbered, become at once available. Each compartment has a capacity of from 150 to 200 separate sheets of paper, with four wide compartments at the bottom, each capable of holding 1,000 or more sheets.

The convenience of this cabinet in the storing of Direction Sheets of Loose-Leaf Note-Books is at once apparent, and Educational Institutions using a Loose-Leaf System of Instruction will readily realize the necessity of ample storage, indexed for ready reference.

The cabinet is substantially built of ash with paneled sides and doors, heavy moulding at top and bottom. It is carried in stock attractively finished in antique oak.

Dimensions over all, — height 40 inches, width 21½ inches, depth 13½ inches.

Each, f. o.b. Factory, **$19.75**

We are prepared to furnish cabinets of any desired finish to match furniture already in the building, and, if the order is sufficiently large, this can be done without extra charge.

No. 1-225c

CHEMISTRY TABLES

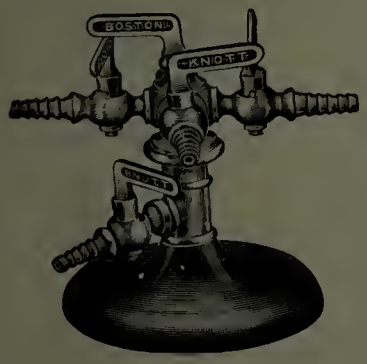
The sink runs through the center, lengthwise of table. Each pupil has individual use of one drawer and one cupboard and uses in common with another pupil the waste jar space and one of the drawers over the waste jar space. All exterior woodwork is ash and the tops are built up from selected narrow straight grained strips, machined, matched and joined in a manner to prevent warping.

1-225a SIX FOOT CHEMISTRY TABLE, — length, 6 feet, width, 3½ feet, height, 34 inches.
This table accommodates eight pupils.
Each, f. o. b. Factory, **$105.00**

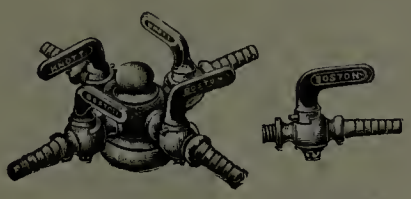
1-225c TWELVE FOOT CHEMISTRY TABLE,—length, 12 feet, width, 3½ feet, height, 34 inches.
This table accommodates sixteen pupils.
Each, f. o. b. Factory, **$198.00**

THE KNOTT SCIENCE LABORATORY FITTINGS

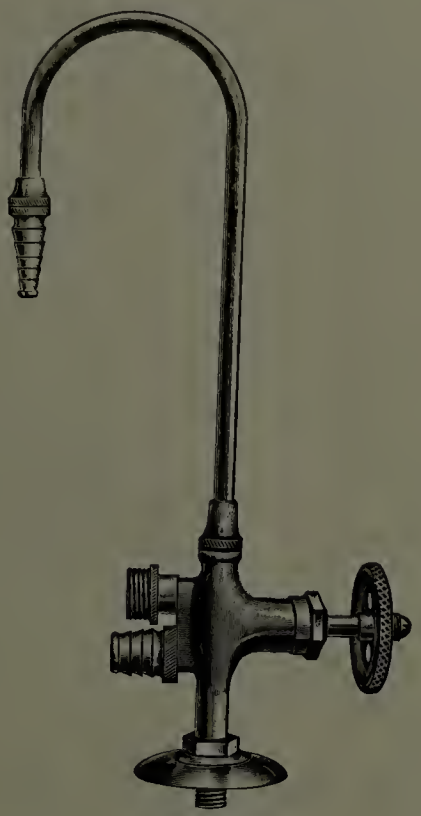
Twenty years ago when we, as pioneers in building laboratory furniture, required gas and water fixtures adapted particularly to science laboratory requirements, it was with considerable surprise that we found that there were no commercial fittings adapted to such special and exacting conditions. After a most critical investigation and study of laboratory and lecture-room needs, we designed the following fittings which have found universal favor. They are used exclusively on all of our laboratory furniture.



No. 1-750



No. 1-725 No. 1-700



No. 1-802

No. 1-800

No. 1-801

KNOTT'S GAS COCKS

The Knott Gas Cocks are of brass. The nipples are long and with five sharp serrations which make it easy to slip on rubber tubing, but impossible to pull it off accidentally. Adjustment is secured by means of a lever handle.

1-700 KNOTT'S LEVER HANDLE GAS COCK, ⅛ inch I. P. **$0.55**
1-710 KNOTT'S SINGLE GAS TURRET, one gas cock **1.45**
1-715 KNOTT'S TWO-WAY GAS TURRET, two gas cocks **1.85**
1-720 KNOTT'S THREE-WAY GAS TURRET, three gas cocks **2.25**
1-725 KNOTT'S FOUR-WAY GAS TURRET, four gas cocks **2.65**
1-750 THE KNOTT MOUNTED FOUR-WAY GAS TURRET. The use of this design obviates all necessity of cutting a table top. It is connected by rubber tubing to a supply cock left at the floor line or above the table **4.50**

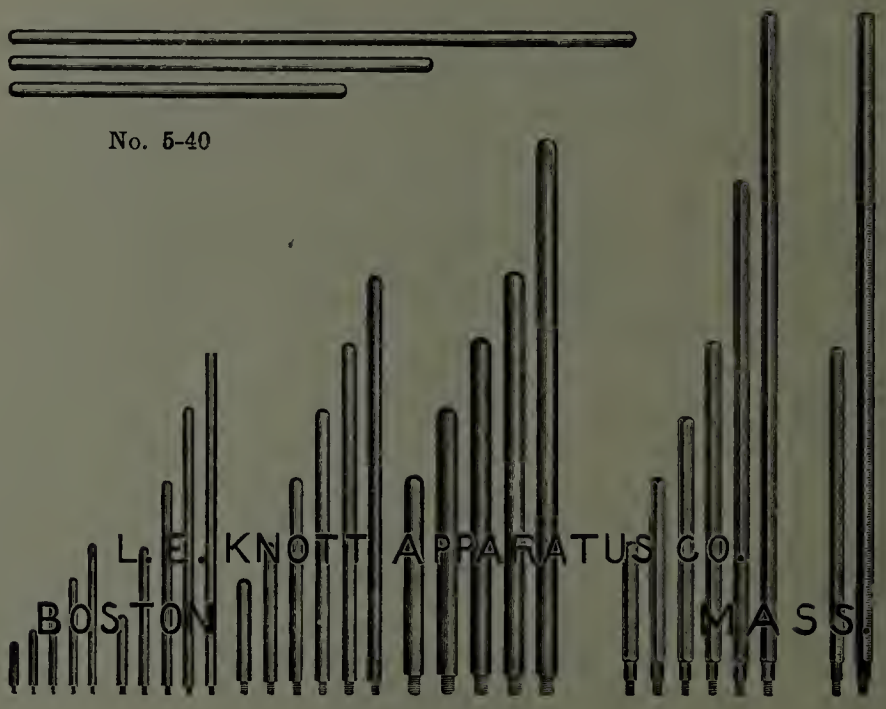
WATER FAUCETS

These faucets are of heavy brass with full nickel finish. Three interchangeable attachments are provided,—two for connecting rubber tubing from ¼ to ¾ inch in diameter, the third, a regular hose bib coupling for attaching an aspirator. Adjustment is secured by a large wheel handle which in actual use has been found the best for student use.

1-800 KNOTT'S WHEEL HANDLE INTERCHANGEABLE NOZZLE STRAIGHT WATER FAUCET, ½ inch I. P. **$2.90**
1-801 ——, BENT WATER FAUCET ½ inch I. P. **3.50**
1-802 ——, GOOSE-NECK WATER FAUCET, ½ inch I. P. **5.00**

LABORATORY SUPPORT RODS

Our Rods are of cold rolled Bessemer steel, copper-plated and heavily nickeled, thus obviating the possibility of rust deterioration. They are straight, of uniform diameter, machine threaded, and shoulders faced to attain a perfect junction when used on our bases and flush plates.



Nos. 5-10 to 5-55

5-10 SUPPORT RODS, 10 millimeter diameter, threaded to fit any hole tapped ¼ × 20.

	a	b	c	d	e	
Length	10	15	20	30	40	centimeters.
Each	**$0.16**	**.18**	**.20**	**.25**	**.29**	

5-15 SUPPORT RODS, 13 millimeter diameter, threaded to fit any hole tapped ⅜ × 16.

	a	b	c	d	e	
Length	20	40	60	80	100	centimeters.
Each	**$0.25**	**.35**	**.48**	**.60**	**.80**	

5-20 SUPPORT RODS, 19 millimeter diameter, threaded to fit any hole tapped ½ × 12.

	a	b	c	d	e	f	
Length	30	40	60	80	100	120	centimeters.
Each	**$0.42**	**.52**	**.70**	**.88**	**1.00**	**1.35**	

5-30 SUPPORT RODS, 30 millimeter diameter, threaded to fit any hole tapped ¾ × 10.

	a	b	c	d	e	
Length	60	80	100	120	160	centimeters.
Each	**$1.65**	**1.90**	**2.30**	**2.45**	**3.35**	

5-40 SUPPORT RODS, for use as horizontal rods, 19 millimeter diameter, ends rounded.

	a	b	c	
Length	100	125	185	centimeters.
Each	**$1.10**	**1.35**	**2.20**	

5-50 SQUARE SUPPORT RODS, 19 millimeters square, one end turned to 19 millimeter diameter, and threaded to fit any hole tapped ½ × 12. No. **5-50 d-f** are most frequently used as bed-rods of optical benches.

	a	b	c	d	e	f	
Length	40	60	80	100	120	200	centimeters.
Each	**$1.15**	**1.55**	**1.95**	**2.30**	**3.40**	**4.45**	

5-55 SQUARE SUPPORT RODS, same as Nos. **5-50d** and **5-50f,** but graduated to millimeters. A few of these rods are valuable additions to every laboratory, as they may be used in many ways besides as bed-rods for optical benches, — the purpose for which they were originally intended.

	a	b	
Length	100	200	centimeters.
Each	**$6.50**	**10.75**	

MISCELLANEOUS BASES

Nos. 5–100 to 5–215

TRIPOD BASES

Our line of Tripod Bases is scientifically designed to give the greatest possible degree of stability without occupying too much room on the working table. The nine sizes of the series fill all needs from the standpoint of size, stability, and the use of all the rods listed on the previous page. Each tripod is faced top and bottom that shoulders of Support Rods may make close junction and may be in true perpendicular with the plane of the base. All holes are machine drilled and threaded.

Our castings are uniformly smooth, thus offering a good surface for a strikingly smooth and beautiful finish. All sizes are carried in stock with and without leveling screws.

5–100	**TRIPOD BASE,** with leveling screws, length of leg 6 centimeters, tapped ¼ × 20 to take any 10 millimeter rod	$0.84
5–101	" " Same as above, without leveling screws	.26
5–104	**TRIPOD BASE,** with leveling screws, length of leg 8 centimeters, tapped ¼ × 20 to take any 10 millimeter rod	.98
5–105	" " Same as above, without leveling screws	.28
5–110	**TRIPOD BASE,** with leveling screws, length of leg 10 centimeters, tapped ¼ × 20 to take any 10 millimeter rod	1.10
5–111	" " Same as above, without leveling screws	.48
5–114	**TRIPOD BASE,** with leveling screws, length of leg 12 centimeters, tapped ¼ × 20 to take any 10 millimeter rod	1.20
5–115	" " Same as above, without leveling screws	.68
5–120	**TRIPOD BASE,** with leveling screws, length of leg 14 centimeters, tapped ⅜ × 16 to take any 13 millimeter rod	1.35
5–125	" " Same as above, without leveling screws	.72
5–130	**TRIPOD BASE,** with leveling screws, length of leg 18 centimeters, tapped ⅜ × 16 to take any 13 millimeter rod	1.85
5–135	" " Same as above, without leveling screws	.94
5–140	**TRIPOD BASE,** with leveling screws, length of leg 18 centimeters, tapped ½ × 12 to take any 19 millimeter rod	1.85
5–145	" " Same as above, without leveling screws	.94
5–150	**TRIPOD BASE,** with leveling screws, length of leg 21 centimeters, tapped ½ × 12 to take any 19 millimeter rod	2.15
5–155	" " Same as above, without leveling screws	1.10
5–160	**TRIPOD BASE,** with leveling screws, length of leg 26 centimeters, tapped ½ × 12 to take any 19 millimeter rod	3.15
5–165	" " Same as above, without leveling screws	1.55
5–170	**TRIPOD BASE,** with leveling screws, length of leg 26 centimeters, tapped ¾ × 10 to take any 30 millimeter rod	3.15
5–175	" " Same as above, without leveling screws	1.55
5–180	**TRIPOD BASE,** with leveling screws, length of leg 50 centimeters, tapped ¾ × 10 to take any 30 millimeter rod	6.90
5–185	" " Same as above, without leveling screws	4.80

ROUND BASES

In the design of our Round Bases we have followed the same rules for stability as in Tripod Bases listed above. Our Castings are uniformly smooth, bases faced top and bottom, machine drilled and tapped, handsomely finished.

5–200	**ROUND BASE,** diameter 8 centimeters, tapped ¼ × 20 to take any 10 millimeter rod	$0.20
5–205	——, diameter 10 centimeters, tapped ¼ × 20 to take any 10 millimeter rod	.22
5–210	——, diameter 12 centimeters, tapped ⅜ × 16 to take any 13 millimeter rod	.36
5–215	——, diameter 15 centimeters, tapped ⅜ × 16 to take any 13 millimeter rod	.50

5–240 "INSTITUTE" H-BASE. The distinctive shape of this base affords a stability equal to that of a round base and in addition enables the experimenter to place a jar or other apparatus within one inch of the support rod. The curvature is somewhat greater than that of a 4 × 5 battery jar. Threaded ¼ × 20 to take any of our 10 mm. rods. **$0.60**

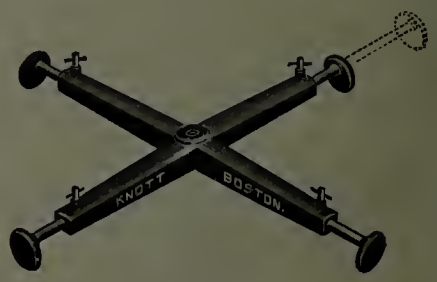
No. 5–242

5–242 "HARCOURT" SPECIAL H-BASE. This base is more massive than above and is threaded ½ × 12 to take any of our 19 mm. rods. Curvature somewhat greater than that of a 6 × 8 battery jar. We utilize this base in a number of our instruments. See Nos. **43–270, 52–10, 53–200, 53–205, 53–215, 62–50, 92–75,** etc., etc. **$1.00**

THE KNOTT ADJUSTABLE ECCENTRIC LEVELING BASES

The design of our Adjustable Eccentric Leveling Base is the outgrowth of a demand for a base of great stability, yet one which will permit placing the base close to other apparatus on the lecture table. The telescoping extension legs give wide range of usefulness. With the two sizes we are able to meet the stability of any round bases from 11¼ to 32 inches in diameter. The eccentric discs on the end of each extension leg give a positive and easily operated level adjustment.

No. 5–250
Patent Pending



No. 5–252
Patent Pending

5–250 "THE KNOTT" ADJUSTABLE ECCENTRIC LEVELING BASE, adjustable to cover an area from 11¼ to 18¼ inches in diameter **$2.35**

5–252 ——, adjustable to cover an area from 18½ to 32 inches in diameter **3.65**

No. 5–260

5–260 ANDREW'S PLATE BASE. There has been considerable demand for a base of the right dimensions to carry a number of support rods so that apparatus might be set up on a lecture table and moved bodily from place to place. The base which we list was designed by Mr. Calvin H. Andrews of the High School of Commerce, Worcester, Mass., and is the most satisfactory design which we have yet seen.

It is provided with five holes on a line through the center of the base, one threaded ⅜–16 and four ½–12, properly located for most convenient use. The base is massive in construction, size 10 × 18 inches. We recommend two of these bases for each lecture table . . . . . Each, **$4.90**

Nos. 5–270 to 5–274

FLUSH PLATES, for inserting in any laboratory table flush with the top. These plates are heavily nickel-plated and polished. When fitted to a table and screwed into place, they offer a support amply rigid for all laboratory operations.

5–270 FLUSH PLATE, tapped ¼ × 20 to take any 10-millimeter rod **$0.35**

5–272 ——, tapped ⅜ × 16 to take any 13-millimeter rod . . . . . **.45**

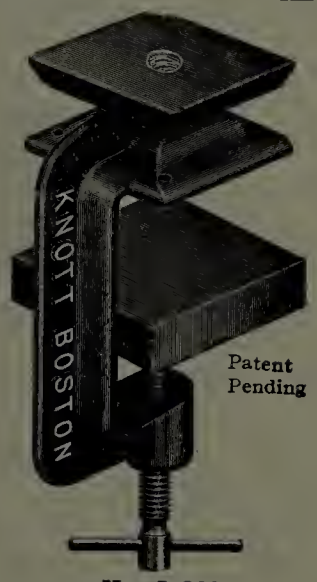
5–274 ——, tapped ½ × 12 to take any 19-millimeter rod . . . . . **.70**

MISCELLANEOUS SUPPORTS

No. 5–350

5–350 **TABLE CLAMP** for attaching to edge of table to hold round or square rods in either horizontal or vertical position. V's and extra broad flange are carefully milled. To be used on table 7.5 centimeters or less thick **$1.40**

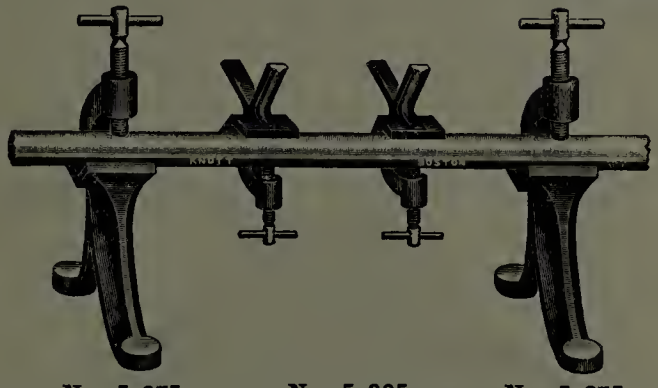
5–360 **TABLE CLAMP** for attaching to edge of table to hold round or square rods in vertical position. This design obviates danger of injury to table, yet at same time, from its structure offers a rigid support. May be used with our Interlocking T-Beam Attachments, "Series B." Tapped ½ × 12 to take 19-millimeter rod . . . **1.90**



Patent Pending

No. 5–360

No. 5–365



No. 5–375 No. 5–385 No. 5–375

5–365 **TABLE CLAMP,** similar to above but less massive and cannot be used with our Interlocking T-Beam Attachments, "Series B." Tapped ⅜ × 16 to take any of our 13 mm. rods. . . . . **$ .85**

5–366 ——, tapped ½ × 12 to take any of our 19 mm. rods. **1.00**

5–375 **END SUPPORTS** for supporting rods in a horizontal position, originally designed for holding bed-rod of optical benches. Extreme care is exercised in machining these supports so that they will meet all requirements . . . . . Each **.55**

5–385 **SECONDARY SUPPORTS** for attaching to round or square rods to support objects in horizontal position. Convenient for holding telescopes; also for levels in level-testing experiments . Each **.42**

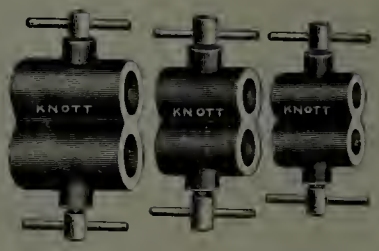
Nos. 5–400 to 5–415

5–400 **STAND TUBE,** into which a 13-millimeter rod may be telescoped and clamped at desired heights within range of 20 centimeters, — the height of the tube. In conjunction with a base tapped ⅜ × 16 and with **STAND TOPS** Nos. **5–475** and **5–480,** will make an adjustable table support **$1.25**

5–405 ——, same as above, but 30 centimeters long **1.45**

5–410 **STAND TUBE** for use as in No. **5–400,** to take 19-millimeter rod, and will fit any base tapped ½ × 12. Length 30 centimeters. Will require No. **5–485** or **5–490** **2.00**

5–415 ——, same as above, but 40 centimeters long **2.25**



Nos. 5–430 to 5–440

No. 5–450

5–430 **EXTENSION CLAMP,** for holding two rods adjustably parallel to each other. For two 19 millimeter rods $0.65

5–435 ——, same as above, but for two 13 millimeter rods 54

5–440 ——, same as above, but for two 10 millimeter rods 44

5–450 **V OPENING EXTENSION CLAMP** for holding two rods adjustably parallel to each other. This clamp has been designed to obviate the inconveniences of the old form with parallel holes which must be attached to the rod by placing it over the ends. Our new design for use with 10 to 19 millimeter rods may be slipped on the rod and clamped by the nickel-plated T screw 55

Nos. 5–470 to 5–490

5–470 **STAND TOP,** 15 centimeters diameter, tapped for use with any 10 millimeter rod threaded ¼ × 20. Frequently used in conjunction with Stand Tube No. **5–400** or **5–405,** and a suitable base to form an adjustable table. Made of three-ply wood to prevent warping. $0.98

5–475 **STAND TOP,** 15 centimeters in diameter, but tapped to receive any 13 millimeter rod threaded ⅜ × 16 .98

5–480 ——, same as above, but 20 centimeters in diameter 1.22

5–485 **STAND TOP,** 20 centimeters in diameter, but tapped to receive any 19 millimeter rod threaded ½ × 12 1.44

5–490 ——, same as above, but 30 centimeters in diameter. 1.64

No. 5–510

5–510 **ADJUSTABLE LABORATORY STAND** for table use. This stand is substantially built of metal, with three-ply wood top. This top is adjustable in height from the minimum height of 40 centimeters to a maximum of 70 centimeters.
This stand will be found of great convenience on the lecture table. The stand being heavy and the center of gravity low, the top may be clamped as any table top and a system of rods and clamps utilized to gain greater latitude and adjustment . . . . . $ 9.50

5–511 ——, same as above, top adjustable from 70 to 130 centimeters. 15.00

No. 5–515

No. 5–515a No. 5–515b

5–515 **GEOMETRIC STANDS,** for blocking up apparatus. Set consists of six tripods fitting into each other, the uppermost surmounted by neat wooden top 13 inches in diameter. Top alone with its leveling screws gives an adjustment from 2⅜ inches, the minimum height, to 3 inches, the maximum. Each tripod varies height by 1⅛ inches. Total maximum height 8½ inches. Per Set of Six **$4.65**

5–515a **TRIPOD WITH WOOD TOP, and LEVELING SCREWS,** as used in above. . . . . Each **2.25**

5–515b **TRIPOD** only, as used in above . . . . . Each **.50**

Nos. 5–525 to 5–545

5–525 **PLATFORM** for 10 millimeter rod. Made of cast iron, top carefully milled true. Top 7 × 8.5 centimeters **$0.60**

5–527 ——, same as above, for 19 millimeter rod . . . . . **.60**

5–530 ——, same as above, for 10 millimeter rod, top 8.5 × 11.5 centimeters . . . . . **.75**

5–535 ——, same as above, for 13 millimeter rod, top 8.5 × 11.5 centimeters . . . . . **.75**

5–540 ——, same as above, for 13 millimeter rod, top 11.5 × 15.5 centimeters . . . . . **.94**

5–545 ——, same as above, for 19 millimeter rod, top 14.5 × 21.5 centimeters **1.50**

No. 5–570

5–570 **WALL STAND,** of general utility in laboratory practice. Designed to be placed on a rail fixed to the wall or laboratory table. Wood plate, 30 centimeters in diameter, oil and wax finish, mounted adjustably on 19 millimeter rod **$12.50**

No. 5–590

No. 5–595
Patent Pending

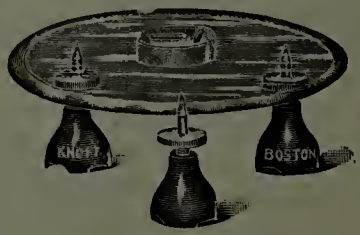
5–590 **KNIFE EDGE BRACKET** for attachment to the side of a room as a knife edge support for a rod in Bending Beam experiments.
This bracket is made of cast iron from a pattern of our own design. It is handsomely japanned and the knife edge carefully milled true . . . . . Each **$0.60**

5–595 **KNIFE EDGE CLAMP** for attaching to the edge of a table top to form an adjustable support for a beam in Bending Beam experiments.
This clamp is one of our T-Beam Series (see No. **5–1060**) and highly recommended for the universal adaptation which is one of its unique features.
Clamp complete as illustrated **1.59**

5–1060 **KNIFE EDGE CLAMP ATTACHMENT ONLY** . . . . . **.65**

5–1000 **"HARCOURT" UNIVERSAL T-BEAM BASIC CLAMP "A."** . . . . . **.94**

5–596 **KNIFE EDGE CLAMP** for attaching to the edge of a table, but knife edge not adjustable . . . . **.55**



No. 5–610

5–610 **LEVELING SCREWS** for use in sets of three for rapidly leveling a plane surface. Made entirely of metal, base accurately milled. Adjustable from minimum height of 65 millimeters to 90 millimeters.
Per set of three **1.40**

Nos. 5–635 to 5–638

Nos. 5–645 to 5–647

5–635 **COLLAR** for allowing a clamped rod to freely revolve and yet keeping rod at height fixed by position of collar. Designed for 30 millimeter rod **$0.58**

5–636 ——, same as above but for 19 millimeter rod . . . . . **.48**

5–637 ——, same as above but for 13 millimeter rod . . . . . **.39**

5–638 ——, same as above but for 10 millimeter rod . . . . . **.33**

5–645 **HOOK COLLAR** for 10 millimeter rod. The addition of a hook to a collar has been found exceedingly useful in our laboratory work. Its use as a support may be noted in illustration of Nos. **27-290** and **27–300.** It may readily be adapted to a multitude of uses when a system of Interchangeable Laboratory Supports is a part of the school equipment . . . . . Each **.24**

5–646 ——, same as above but for 13 millimeter rod . . . . . Each **.28**

5–647 ——, same as above but for 19 millimeter rod . . . . . Each **.55**

No. 5–670

5–670 **RIGHT ANGLE PIECE** for clamping two 10 millimeter rods at right angles to each other. Neatly nickel-plated with two nickel-plated T-screws **$0.50**

CLAMPS

Our **Clamps** are designed to give maximum strength at stress points with use of as little metal as practical to preserve symmetry. All our clamps are ribbed at points of stress; our castings are uniform and smooth, thus presenting a good surface for a smooth, handsome, and durable finish; all parts designed to be at right angles or parallel are as accurately so as machinists' skill can produce. As jigs and standard gauges are used as far as practicable, each lot will be found uniform in dimensions. All holes are reamed to a sliding fit; all screws are heavily nickel plated and of size proportional to size of clamp; all V's are accurately milled.

No. 5–725 No. 5–745 No. 5–760 No. 5–765 No. 5–770 No. 5–785 No. 5–810 No. 5–825

5–725 **RIGHT ANGLE CLAMP,** for holding two rods in planes accurately at right angles to each other. V opening to clamp 13 millimeter rod, hole for 10 millimeter rod $0.45

5–730 ——, same as above, but V opening to clamp 19 millimeter rod, hole for 13 millimeter rod 65

5–735 ——, for use in holding optical bench accessories. V opening to clamp 19 millimeter rod, hole for 13 millimeter rod. Central (zero) point indicated 90

5–745 **RIGHT ANGLE CLAMP,** V opening to clamp 30 millimeter rod, hole 19 millimeters 90

5–760 **RIGHT ANGLE CLAMP,** for holding two rods in planes accurately at right angles to each other. Two V openings for clamping 13 millimeter rods 44

5–765 ——, same as above, but with two V openings for clamping 19 millimeter rods 63

5–770 **"HARCOURT" RIGHT ANGLE CLAMP,** for holding two rods in same plane at right angles to each other. Two V openings for clamping 13 to 19 millimeter rods, one accurately perpendicular to the other.

This form of clamp will be found a marked improvement over types on the market, as more rapid changes and adjustments are possible. Its universal adaptability to work not possible with old forms is readily apparent 95

5–785 **RIGHT ANGLE CLAMP,** for holding two rods in same plane but accurately at right angles to each other. V opening to clamp 19 millimeter rod, tapped $\frac{1}{4} \times 20$ to receive 10 millimeter rod 45

5–790 ——, same as above, but tapped $\frac{3}{8} \times 16$ to receive 13 millimeter rod 55

5–810 **RIGHT ANGLE CLAMP,** for holding two rods in same plane but at right angles to each other. V opening to clamp to 19 millimeter rod, hole 10 millimeters. Convenient for holding accessories having shank 10 millimeters in diameter 68

5–815 **OPTICAL BENCH RIGHT ANGLE CLAMP,** same as above, but with central (zero) point indicated. V opening to clamp to 19 millimeter rod, hole for 10 millimeter rods 78

5–820 ——, same as above, but V opening to clamp 19 millimeter rod, hole 13 millimeters 85

5–825 **RIGHT ANGLE CLAMP WITH SLIDING SPRING CONTACT,** same as No. **5–815,** but with addition of device which holds clamp firmly to the bed-rod yet at same time allowing of firm sliding motion along the rod. This clamp is advised for use as support for Photometer Boxes as it allows of motion along rod without unlocking the set screw . . . . . Each 1.70

No. 5–840
Patent Pending.

5–840 SWIVEL-CLAMP UNIVERSAL HOLDER, for holding in any position flat or round objects, thermometers, burettes, tubes, screens, telescopes, telescope scales, and, in fact, any object flat or cylindrical which is not over 50 millimeters in diameter nor over 155 millimeters wide and 30 millimeters thick.

This device consists essentially of two parts,—a holder and a swivel-clamp, the holder attached to the swivel-clamp in an ingenious manner by which it may be firmly set in position by a T screw, and yet without removing from the rod, capable of universal motion in one plane by simply diminishing the pressure of the screw against the rod. This swivel-clamp will be found a prominent feature in the use of this holder.

The holder is designed to meet the requirements of a general lecture table clamp. The essential part is a broad plate. At the edge of this broad plate are two projections against which the object to be held is laid. A plunger rod carries an arm which is adjustable along the rod and it in turn carries an adjustable contact rod tipped with cork. In use the object is placed against the projections at the edge of the broad plate. Knob at end of plunger rod is pushed in, thus acting against a compression spring. The arm carrying the contact rod is adjusted on the plunger rod and the position of the contact rod on this arm is adjusted so that when pressure of thumb is removed from compression spring the object is firmly clamped by force of the spring. (See Figure **1**.) The projection to the rear of the arm is a straight rod to be used with arm reversed on plunger rod when a flat object is to be clamped. (See Figures **2** and **3**.)

This Universal Holder will be found a valuable addition to any laboratory. Its use is unlimited; positions possible are multitudinous; facility, convenience, and rapidity of changes are unexcelled. As it will hold a great range of sizes from small to large, adapting itself instantly to these changes, and support objects in any position it might well be called a system of clamps combined in one.

It is handsomely finished in bright nickel-plate. All parts are carefully fitted and substantial in structure. The most convenient and generally useful lecture table clamp yet designed. Two should be provided for each lecture table . . . . . Each **$4.50**

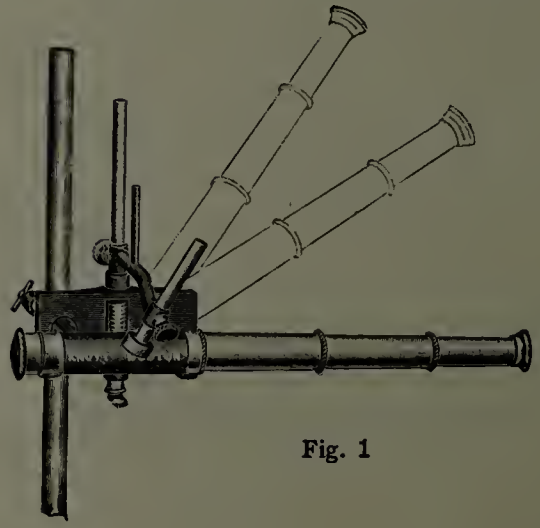
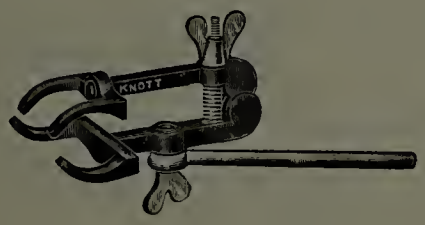


Fig. 1

Fig. 2

Fig. 3

Nos. 5–850 and 5–855



No. 5–875

5–850 **UNIVERSAL RIGHT ANGLE CLAMP,** for holding two rods in various planes at right angles to each other. Provided with swivel for locking. Two V openings to clamp 19 millimeter rods . . . **$1.05**

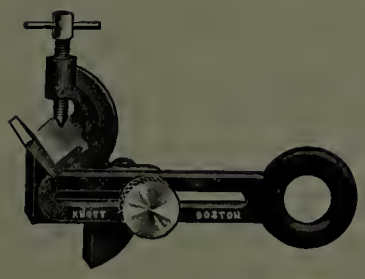
5–855 ——, same as above, but with two V openings for clamping 13 millimeter rods . . . . . **.90**

5–875 **UNIVERSAL CLAMP,** for large objects up to 8 centimeters in diameter, regular or irregular in shape. Position adjustable by swivel through 180 degrees. Finished in japan and nickel plate **1.75**

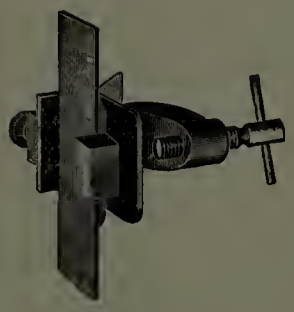
No. 5–887

No. 5–891

No. 5–885



No. 5–889



No. 5–895

5–885 **BOTTLE CLAMP,** for clamping a bottle by its neck and supporting same to an upright. V clamp for 13 millimeter rod. Will clamp firmly any diameter from 25 millimeters to 30 millimeters. In use see No. **53–200** **$0.85**

5–887 **ADJUSTABLE TUBE CLAMP,** for supporting a tube in an upright or horizontal position. This is a two-part casting, one part designed with a V clamp for attaching to a 13 millimeter rod, the second part held adjustably to the first by two thumb screws, thus accommodating a tube from 1¼ inches (32 millimeters) to 1¾ inches (45 millimeters) in diameter. In use see No. **53–200** . . **.95**

5–889 **ADJUSTABLE ARM SUPPORT WITH CLAMP.** This is a two-part casting, one provided with a V for clamping to a 13 millimeter rod, the other with countersunk hole at the end of a slotted arm. This arm is adjustable to the length of the slot and may be clamped in any position by means of a thumb screw. In use see No. **53–200** . . . . . **.85**

5–891 **ROD V CLAMP,** for use with any V clamp in securing a greater latitude of adjustment. V opening to take 10 or 13 millimeter rod. Rod 13 millimeters diameter, 11 centimeters long . . . . . **.55**

5–895 **METER STICK CLAMP,** V opening for clamping to a 13 or 19 millimeter rod, face plate and adjustable locking device for holding the standard meter stick. Surfaces of V and of face plate carefully milled parallel . . . . . **.54**

No. 5-900

5-900 **FOUR PENDULUM CLAMP,** for adjustably supporting four pendulums. This clamp, similar in design to the one on the market is improved so that it may carry four pendulums, thus making possible a direct comparison of pendulum lengths of periods as **1:2:3:4.** The clamp itself is of a smooth, uniform casting, carrying four removable clamps designed to give exact points of suspension for accurate measurement of lengths. This clamp consists of a flat brass piece with guide pin held to the main clamp by a polished and lacquered thumb screw **$1.75**

5-902 **THREE PENDULUM CLAMP,** similar to above but usual form designed to hold three pendulums . . . . . **.75**

For **Complete Pendulum Apparatus,** see Section **25.**

No. 5-905

5-905 **BI-FILAR PENDULUM CLAMP** for holding four pendulums in bi-filar suspensions. This clamp obviates the inconveniences of the ordinary type in that it gives a directive force to the swinging pendulums. It is especially adapted for four pendulums of different vibration periods.

It consists of a smooth uniform casting in which are placed tapered plugs, two for each pendulum ball. These tapered plugs are carefully fitted to their respective holes, and the lengths of the suspending cords are readily adjusted and held by the friction of the tapers against the sides of the holes **$2.35**

For **Complete Apparatus,** see Section **25.**

No. 5-915

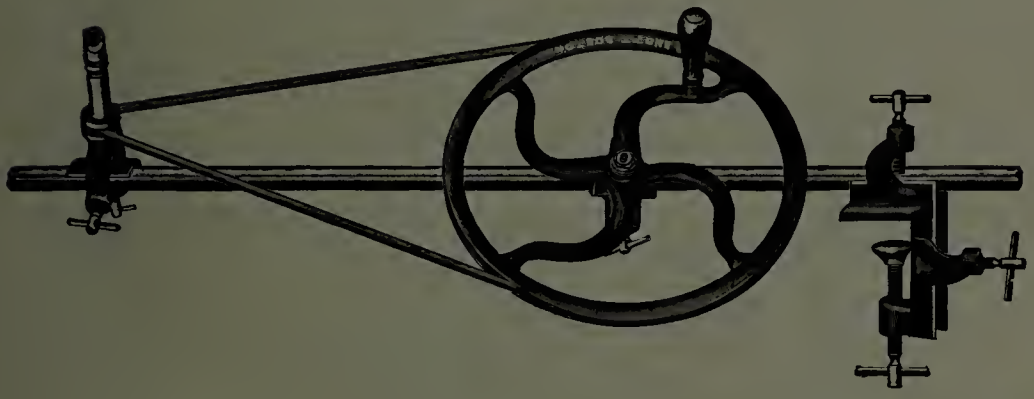
5-915 **HAND BALANCE SUPPORT** or **CLAMP** for attaching to a Tripod Stand, and supporting adjustably a hand balance. This clamp is designed for use on a 13 millimeter rod. In use, a stiff tape, a shoestring being excellent, is threaded through the ring of the hand balance and then the ends threaded through the holes in the clamp, then wrapped once about the binding screw.

Height of the balance is readily adjusted, first (coarse adjustment), by position of clamp on the rod, second (fine adjustment), by drawing tape through the holes in the clamp **$0.28**

No. 5–920

5–920 TELESCOPE CLAMP, for holding any round or square object from 7.5 to 16 centimeters in length, especially designed for holding Reading Telescopes. This clamp is constructed of metal throughout, with clamping device consisting of two V's adjustable along the clamping rod to accommodate the different lengths of the objects. A strap adjustable to the size of the object is designed to bind it without danger of injury. The clamping rod is tapped ¼ by 20 on two faces to take the 10 millimeter rod, securing positions as may be noted in the illustration **$2.45**

MECHANICAL ROTATOR



Mounted horizontally

Mounted vertically

The accompanying illustrations show the method employed in setting up a Mechanical Rotator, using the attachments listed below in conjunction with No. **5–350** Table Clamp and No. **5–20e** Support Rod.

5–925 MECHANICAL ROTATOR ATTACHMENTS, consisting of a Drive Wheel and Clamp and a Spindle and Clamp, the latter provided on one end with groove for belt, socket and set screw; on the other, with a special headed lock nut.
Drive Wheel and Clamp, Spindle and Clamp and Round Belt . . . **$6.75**

5–926 DRIVE WHEEL and **CLAMP,** including Round Belt **3.50**

5–927 SPINDLE and **CLAMP,** one end grooved for round belt and provided with socket and set screw; other with special headed lock nut **3.25**

5–928 ROUND LEATHER BELT with patent belt fastener . . . . . **.65**

For other Mechanical Rotator see No. **21–10.**

MOUNTED PULLEYS, MIRRORS LENS HOLDERS, ETC.

No. 5–950

No. 5–952

No. 5–960

No. 5–970

No. 5–975

5–950 **BALL-BEARING PULLEY MOUNTED ON ROD,** axis at right angles to rod. Nickel plated, **BALL-BEARING, STEEL PULLEY,** 60 millimeters diameter, mounted in stirrup and attached to nickel-plated rod, 10 millimeters diameter, 15 centimeters long. These **MOUNTED PULLEYS** must not be confused with the brass pulleys mounted on cone bearings, as by means of ball race we secure a frictionless pulley, running true, tested to uphold 50 pounds **$0.94**

5–952 **BALL-BEARING PULLEY MOUNTED ON ROD,** axis in same plane as rod: *i. e.*, pulley will run at right angles to rod. **BALL-BEARING PULLEY,** 60 millimeters diameter, mounted on nickel-plated rod, 10 millimeters diameter, 15 centimeters long, pulley tested to uphold 50 pounds . . **.90**

5–960 **ADJUSTABLE 50 M. M. PLANE MIRROR ON ROD.** Mirror 50 millimeters diameter, adjustable in stirrup about a horizontal axis, adjustable on rod about a vertical axis. Mounted on nickel-plated rod, 10 millimeters diameter, 15 centimeters long **1.95**

5–970 **UNIVERSAL LENS HOLDER,** for lenses up to 4 inches in diameter. This ingenious holder is adjustable by means of the rods and set screws to hold and clamp firmly in or off center, lenses up to 4 inches diameter. Handsomely oxidized black with nickel-plated rods . . . . . **.88**

5–975 ——, same as above, for holding lenses up to 2 inches in diameter . . . . . **.78**

BASES, SUPPORT RODS, CLAMPS

No. 5–990 LECTURE LIST "A"

A carefully selected list of bases, rods, clamps, and attachments, covering the essentials and designed for schools not in position to procure a more complete outfit:

Quan.	Number	Item
		SUPPORT BASES
2	**5–250**	Eccentric leveling Bases
		SUPPORT RODS
1	**5–15b**	Support Rod 13 mm. × 40 cm.
1	**5–15c**	" " 13 mm. × 60 cm.
1	**5–20b**	" " 19 mm. × 40 cm.
1	**5–40b**	" " 19 mm. × 125 cm.
2	**5–20e**	" " 19 mm. × 100 cm.
		CLAMPS
2	**5–450**	Extension Clamps
2	**5–765**	Right Angle Clamps
2	**5–770**	Right Angle Clamps
1	**5–850**	Swivel Clamp
1	**5–895**	Meter Stick Clamp
1	**5–900**	Pendulum Clamp

Quan.	Number	Item
		MISCELLANEOUS
1	**5–540**	Platform
4	**5–646**	Hook Collars for 13 mm. rod
1	**5–950**	Pulley on rod
2	**5–952**	Pulleys on rod
1	**5–975**	Universal Lens Holder
		T-BEAM BASIC CLAMPS
2	**5–1000**	Basic Clamps "A"
2	**5–1150**	Basic Clamps "B"
1	**5–1005**	Basic Rod Swivel Clamp
1	**5–1025**	Single Rod Attachment
1	**5–1030**	Three Rod Attachment
1	**5–1035**	Swivel Post Attachment
2	**5–1060**	Knife Edge Attachments
1	**5–1070**	Balance Cradle
1	**5–1080**	Pulley Clamp

5–990 **LECTURE LIST "A"** complete, as listed above . . . . . Set **$36.00**

(See next page)

BASES, SUPPORT RODS, CLAMPS

No. 5-995 LECTURE LIST "B"

The following list has been made up by teachers of long experience and is considered and advised by them as an equipment ample for lecture table demonstrations. The selection has been made with the intention of covering every need for the lecture table, with suitable bases, support rods, clamps, and attachments which will be needed in assembling and adjusting the apparatus used in the most complete lecture table demonstration courses. Suggestions for enriching this list either by new designs or by additions of old will be greatly appreciated.

Quan.	Number	Item
		SUPPORT BASES
1	5-101	Tripod Base, 6 cm. for 10 mm. rod
2	5-105	" " 8 cm. for 10 mm. rod
1	5-114	" " 12 cm. for 10 mm. rod
2	5-115	" " 12 cm. for 10 mm. rod
1	5-140	" " 18 cm. for 19 mm. rod
1	5-170	" " 26 cm. for 30 mm. rod
4	5-250	Eccentric Leveling Bases, 11¼–18¼ inches
2	5-252	" " " 18½–32 inches
		SUPPORT RODS
2	5-10b	Support Rods, 10 mm. × 15 cm.
2	5-10c	" " 10 mm. × 20 cm.
2	5-10e	" " 10 mm. × 40 cm.
2	5-15b	" " 13 mm. × 40 cm.
2	5-15c	" " 13 mm. × 60 cm.
2	5-15e	" " 13 mm. × 100 cm.
2	5-20b	" " 19 mm. × 40 cm.
2	5-20c	" " 19 mm. × 60 cm.
2	5-20e	" " 19 mm. × 100 cm.
1	5-20f	" " 19 mm. × 120 cm.
1	5-30d	" " 30 mm. × 120 cm.
1	5-40a	" " 19 mm. × 100 cm.
1	5-40c	" " 19 mm. × 185 cm.
1	5-50d	" " 19 mm. × 100 cm.
1	5-50e	" " 19 mm. × 120 cm.
1	5-400	Stand Tube, 20 cm. for 13 mm. rod
1	5-405	" " 30 cm. for 13 mm. rod
1	5-410	" " 30 cm. for 19 mm. rod
1	5-415	" " 40 cm. for 19 mm. rod
		CLAMPS
2	5-360	Table Clamps
2	5-450	Extension Clamps
2	5-725	Right Angle Clamps
2	5-735	" " " V, 19 mm. hole 13 mm.
1	5-745	" " " V, 30 mm. hole 19 mm.
2	5-760	" " " 2 V's, 13 mm.
2	5-765	" " " 2 V's, 19 mm.
4	5-770	" " " 2 V's, 19 mm
1	5-785	" " " V, 19 mm., tapped ¼ × 20
1	5-790	" " " V, 19 mm., tapped ⅜ × 16
5	5-810	" " " for optical bench
1	5-825	" " " for photometer
1	5-840	Universal Clamp
1	5-850	Swivel Clamp for 19 mm. rods
1	5-855	" " for 13 mm. rods
1	5-875	Universal Clamp
1	5-887	Adjustable Tube Clamp
1	5-889	Adjustable Arm

Quan.	Number	Item
		CLAMPS
1	5-891	Rod V Clamp
1	5-895	Meter Stick Clamp
1	5-900	Pendulum Clamp
1	5-905	Bi-filar Pendulum Clamp
		MISCELLANEOUS
1	5-510	Adj. Lab. Stand, 40–70 cm.
1	5-515	" " " 70–130 cm.
1	5-525	Platform, rod 10 mm., 7 × 8.5 cm.
1	5-527	" rod 19 mm., 7 × 8.5 cm.
1	5-530	" rod 10 mm., 8.5 × 11.5 cm.
1	5-535	" rod 13 mm., 8.5 × 11.5 cm.
1	5-540	" rod 13 mm., 11.5 × 15.5 cm.
1	5-545	" rod 19 mm., 14.5 × 21.5 cm.
1	5-260	Plate Base
1	5-480	Stand Top, 20 cm. for 13 mm. rod
1	5-485	" " 20 cm. for 19 mm. rod
1	5-490	" " 30 cm. for 19 mm. rod
1 pr.	5-375	End Supports
1 pr.	5-385	Secondary Supports
1 pr.	5-590	Knife Edge Brackets
1 set	5-610	Leveling Screws
1	5-635	Collar for 30 mm. rod
2	5-636	" for 19 mm. rod
1	5-637	" for 13 mm. rod
1	5-638	" for 10 mm. rod
6	5-645	Hook Collars for 10 mm. rod
10	5-646	" " for 13 mm. rod
4	5-950	Pulleys on rod
4	5-952	" on rod
1	5-960	Mirror on rod
1	5-970	Universal Lens Holder, lenses up to 4-in.
1	5-975	" " " " up to 2-in.
		T-BEAM BASIC CLAMPS
4	5-1000	Basic Clamps "A"
2	5-1150	Basic Clamps "B"
2	5-1005	Basic Rod Swivel Clamps
1	5-1025	Single Rod Attachment
2	5-1030	Three Rod Attachments
1	5-1035	Swivel Post Attachment
2	5-1045	Secondary Basic Attachments
1	5-1050	Upright Secondary Attachment
1	5-1055	Meter Stick Attachment
2	5-1060	Knife Edge Attachments
4	5-1065	Stone's Tension Clamp Attachments
4	5-1070	Balance Cradle Attachments
1	5-1075	Micrometer Screw Attachment
1	5-1080	Universal Pulley Attachment
1	5-1085	Chladni's Plate Attachment
1	5-1185	Bench Anvil-Vise Attachment

5-995 LECTURE LIST "B" complete, as listed above . . . . . Set **$173.00**

HARCOURT UNIVERSAL T-BEAM CLAMPS

The Harcourt Universal T-Beam Clamps have been so designed that they accomplish three very important results:

FIRST: They supply to the instructor a series of clamps which, with appropriate rods, will enable him to set up his apparatus in a minimum amount of time.

SECOND: They hold the apparatus, when so set up, correctly and rigidly.

THIRD: They do this at a reasonable cost.

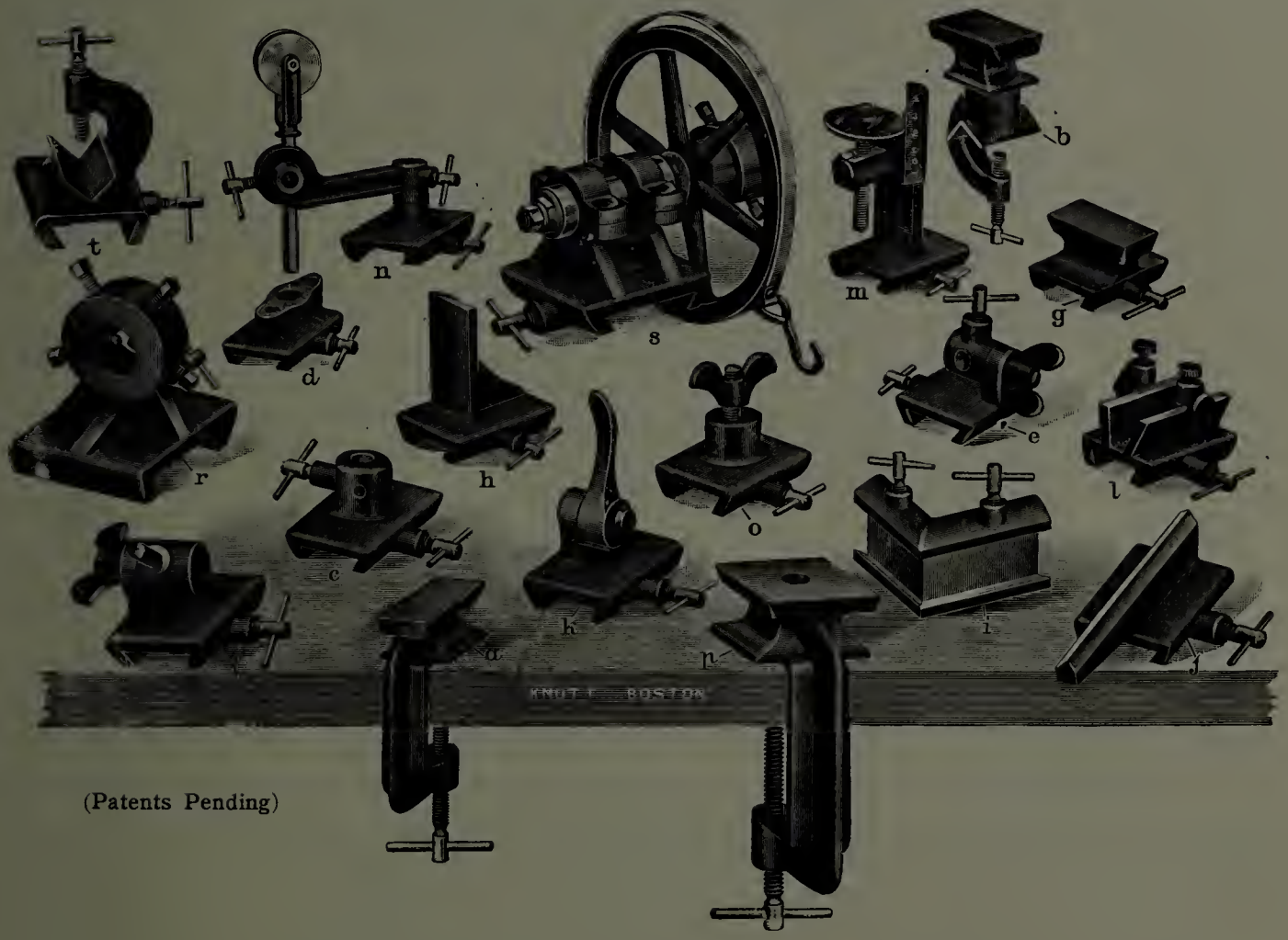
The line which is listed in the following pages, with its lathe-rest interlocking attachments and interchangeable features, gives latitude of operation never before obtained with laboratory accessories.

The Harcourt Universal T-Beam Clamps are divided into two groups, Series "A" and Series "B." In the first series are two basic clamps: the Harcourt Universal T-Beam Basic Clamp "A" and the Basic Rod Clamp. To these basic clamps may be clamped the various Lathe-rest Interlocking Attachments. In Series "B" only one basic clamp is required, as this series is designed only for heavier work, the nature of which would prohibit its use on a rod. The Lathe-rest Interlocking Attachments, therefore, in this series are few compared with those listed in Series "A."

Illustrations covering the vast utility of these series are practically impossible. We secure a greater range of usefulness and stability with our series than heretofore obtained by any other system of laboratory hardware. In our experiments, we have been able to cover practically the entire field of the "Interchangeable Laboratory Supports" by the few attachments which are herewith listed, widening the field and adding to the interchangeable features. If any position or "set-up" is desired that is neither illustrated nor can be procured with our line, we most urgently request the co-operation of the teachers in making known their particular needs.

On the following pages we have listed these two series of Basic Clamps and Interlocking Lathe-rest Attachments. It has seemed impracticable, however, in this catalogue to show by illustrations and descriptions the many ways by which the few designs can be utilized to advantage in the lecture desk demonstrations that previous to the introduction of this line required the many designs heretofore offered.

In a special circular, now in press, we have endeavored to picture a few of the many experiments where intelligent use of Basic Clamps and Interlocking Attachments greatly simplifies lecture and laboratory conduct. Send for this circular.



(Patents Pending)

SERIES "A"

(Letters used in the following descriptions refer to corresponding letters in illustration above.)

5–1000 HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "A" for clamping to a table or any surface not over 6 centimeters thick, as the fundamental support for attaching any of our Universal Lathe-rest Interlocking Attachments listed in this series. ("a" in illustration.) **$0.94**

5–1005 HARCOURT UNIVERSAL T-BEAM BASIC ROD SWIVEL CLAMP for clamping to any 13 or 19 millimeter rod for attaching any of our Universal Lathe-rest Interlocking Attachments listed in this series. ("b" in illustration.) As may be noted from the illustration of this clamp, it is in design similar to the Basic Clamp "A." It has a further important feature, however, impossible of adequate illustration. This feature allows of clamping the double bevel slide in any position without movement of the clamp along the rod. The universal movement is secured by means of an ingenious swiveled V-clamp device readily operated by the nickel-plated T-Screw **1.65**

UNIVERSAL LATHE-REST INTERLOCKING ATTACHMENT

SERIES "A"

5-1025 **SINGLE-ROD ATTACHMENT** for holding a 10 millimeter rod either perpendicular or parallel to face of clamp. The rod is clamped rigidly in place by means of a nickel-plated T screw. ("c" in illustration.) In use, see No. **23-10** $0.68

5-1030 **THREE-ROD ATTACHMENT,** tapped ¼ × 20, ⅜ × 16, and ½ × 12, to hold either a 10, 13 or 19 millimeter rod. ("d" in illustration.) 66

5-1035 **SWIVEL-POST ATTACHMENT** for clamping a 13 millimeter rod which may be swiveled through an arc of 180 degrees and fixed in any position by a wing nut. ("e" in illustration.) In use, see Adjustable Inclined Plane Support, Section 25 84

5-1040 **THREADED SWIVEL-POST ATTACHMENT,** similar to above, but provided with a boss threaded to receive any rod tapped ⅜ × 16. ("f" in illustration.) In use, see Hand Air Pump, Section **42** .74

5-1045 **SECONDARY BASIC ATTACHMENT** for use in conjunction with Basic Clamp "A" to secure a lathe-rest support at right angles to that of the basic clamp. ("g" in illustration.) 66

5-1050 **UPRIGHT SECONDARY BASIC ATTACHMENT** for use in conjunction with Basic Clamp "A," lathe-rest slide perpendicular to clamp. ("h" in illustration.) 68

5-1055 **METER STICK ATTACHMENT** for clamping a meter stick in an upright position. ("i" in illustration.) 74

5-1060 **KNIFE-EDGE ATTACHMENT.** ("j" in illustration.) In use see Knife-Edge Clamp, Section **5**; also Bending Beam Apparatus, Section **23** 65

5-1065 **STONE'S TENSION CLAMP ATTACHMENT.** ("k" in illustration.) In use, see Parallelogram of Force Apparatus, Section **24** 48

5-1070 **BALANCE CRADLE ATTACHMENT,** designed for the standard 250, 500 or 2000 gram Spring Balances. ("l" in illustration.) In use, see Parallelogram of Force Apparatus, Section **24** 66

5-1075 **MICROMETER SCREW ATTACHMENT,** swiveled split-post tension. ("m" in illustration.) For complete description, see Micrometer Screw, Section **12.** In use, see Flexure of Beams Apparatus, Section **23** 3.25

5-1080 **UNIVERSAL PULLEY ATTACHMENT.** ("n" in illustration.) For complete description see Universal Pulley, Section **27** 1.75

5-1085 **CHLADNI'S PLATE ATTACHMENT.** ("o" in illustration.) In use, see Chladni's Figures Apparatus, Section **54** 60

5-1090 **ROD V CLAMP ATTACHMENT** ("t" in illustration.) This clamp will be required if it is desired to clamp one rod to another, especially in obtaining a cross-bar support 68

SERIES "B"

(Letters used in following descriptions refer to corresponding letters in illustration on preceding page.)

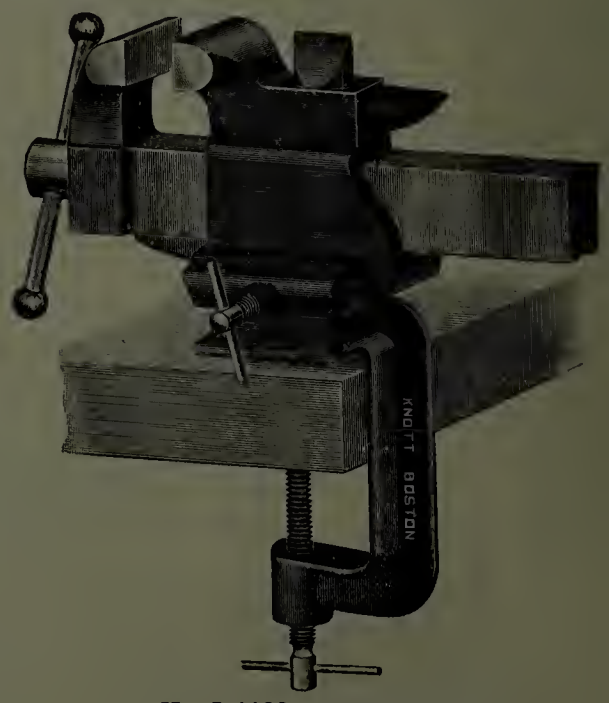
5-1150 **HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "B"** for clamping to a table or any surface not over 8½ centimeters thick as the fundamental support for attaching any of our Universal Lathe-rest Interlocking Attachments listed in this series. ("p" in illustration.) The top plate is drilled and threaded for taking any of our 19 mm. threaded support rods. It will be found particularly useful for holding the uprights on our Physics Table No. **1-120** . . $1.65

5-1175 **BALL-BEARING TORSION OF BEAMS ATTACHMENT.** ("s" in illustration.) In use and for description, see Torsion Apparatus, Section **23** 3.90

5-1180 **FIXED HEAD TORSION OF BEAMS ATTACHMENT.** ("r" in illustration.) In use and for description, see Torsion Apparatus, Section **23.** May be used in four positions 1.35

5-1185 **BENCH ANVIL-VISE ATTACHMENT,** interlocking with Basic Clamp "B" to secure a rigid, substantial bench anvil vise. Spread 5½ inches, jaws 2⅛ inches. Provided with hardened steel cutting-off tool 7.45

5-1186 **BENCH ANVIL-VISE,** consisting of No. **5-1150** Basic Clamp and above attachment, complete 9.10



No. 5-1186 Patent Pending.

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By GEORGE M. TURNER and C. BROOKS HERSEY

Masten Park High School, Buffalo, N. Y.

Perhaps the most distressing problem confronting the science teacher is that of the choice of a suitable laboratory guide for his classes. Requirements differ in different localities. These requirements are governed by many factors, principal among which may be cited the following, — some localities are manufacturing centers, some agricultural, in short, an industrial factor; some schools are not equipped to teach from any one laboratory guide, a condition arising perhaps from frequent changes in the instruction force, each of whom had individual methods. Last, but not least, is the all-important factor of non-uniformity of College Entrance Requirements throughout the country.

Many instructors have solved the problem of meeting the individual school demands by formulating manual directions to meet their own particular conditions, but the problem had never been satisfactorily faced until Messrs. Turner and Hersey edited and authorized for publication the **LOOSE-LEAF NATIONAL PHYSICS NOTE-BOOK DIRECTION SHEETS.** In this publication, in which we have **SOLE SELLING RIGHTS,** a teacher is given a latitude for choice, and the extensive sale of these sheets has demonstrated their success in meeting the particular individual demand of the many who use them in preference to bound manuals.

The number of experiments covered up to the issuance of this catalogue is 132. In this list will be found, not only a latitude for choice of experiments but also for choice in method, thus meeting the demand for Manual Directions to conform to individual equipments. As this number is constantly increasing to keep pace with the advances made in science teaching, the **NATIONAL PHYSICS NOTE-BOOK WILL NEVER BECOME OBSOLETE.**

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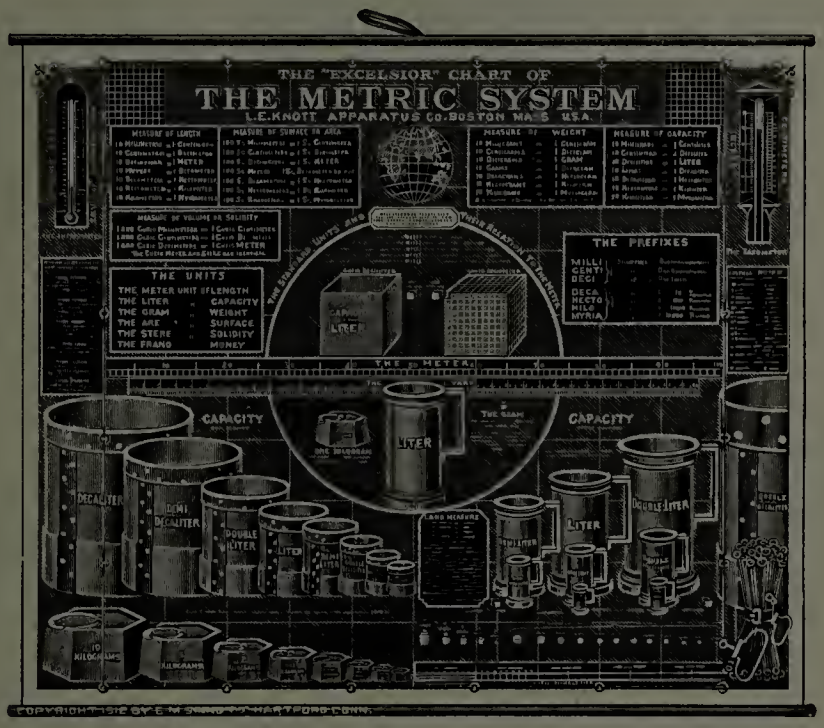

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No. 10–10

10–10 LARGE SIZE METRIC CHART, presenting graphically a comparative grouping of the Metric and English units of weights and measures.

The chart is 50 inches wide and 46 inches high, and the illustrations, beautifully lithographed in colors, are grouped in the best manner for direct comparisons of the two systems. The type is large and distinct and the coloring of the whole chart is such that it will be found not only a valuable, but an ornamental accessory to any laboratory.

Mounted on cloth back and provided with common rollers with hooks for hanging **$2.50**

No. 10–20

10–20 POLISHED DISSECTED LITER BLOCK, graduated, dissected, and **weighted** for the ocular as well as quantitative comparisons in the Metric System of length, area, volume, capacity, and weight.

This block is graduated,—one edge to millimeters, each face into square centimeters; dissectible to 1-10, 1-100, and 1-1000 of its volume; weighted so that each section has a mass equal to an equivalent volume of water.

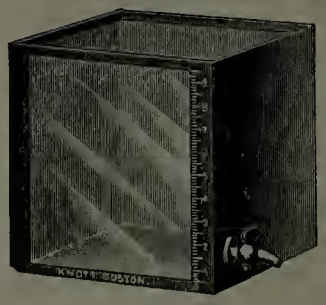
Made of selected hardwood, oil and wax finish, all graduations showing white **$3.00**

No. 10–25

10–25 GRADUATED SOLID LITER BLOCK, for illustrative comparisons of units of length and volume in the Metric System.
This block is graduated as No. **10–20** but neither loaded nor dissectible.
Made of selected hardwood, oil and wax finish, all graduations showing white **$1.35**

10–30 UNGRADUATED CUBIC DECIMETER LITER BLOCK for illustration of size of one cubic decimeter (1000 cubic centimeters).
This block, not being graduated, dissectible, or weighted, does not have the same pedagogic value as the preceding, yet will be found effective in the review of facts deduced by their use.
Made of hardwood with oil and wax finish . . . . . **.65**

NOTE.—Under No. 10-50 will be found listed a block accurately one foot on an edge. It will be found a valuable addition if ocular comparison of size of cubic liter and cubic foot is desired.



No. 10–35

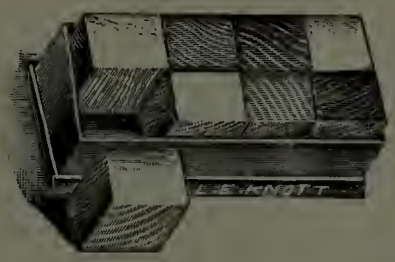
No. 10–45

10–35 BURNISHED COPPER LITER CASE, illustrating quantitatively metric equivalents in measures of capacity, volume, and weight.
This case is constructed so that each edge measures 10 centimeters (one decimeter), having, therefore, a capacity of one cubic decimeter. It is especially adapted to the study of Archimedes' Principle and, applying this principle, to determining the specific gravity and volume of any irregular solid. This case is provided with glass face for inspection of contents of case, an accurate metal scale for measuring contents, and a stop-cock for inlet or outlet of water. By using a balance it may be determined that for every millimeter rise or fall of water as indicated by the scale the net weight varies by 10 grams, thus demonstrating that one gram of water occupies one cubic centimeter space.
Made of burnished copper with water-tight glass face, accurate metal scale and brass inlet cock . . . **$3.00**

10–40 CUBIC DECIMETER LITER CASE with capacity for holding exactly one liter of water. Accurately made of non-corrosive metal, measuring one decimeter on edge internal measurement **1.10**

10–45 GRADUATED CUBIC DECIMETER LITER CASE, same as No. **10–40** but with one face graduated into square centimeters **1.60**

10–50 SOLID CUBIC FOOT BLOCK, furnishing for demonstrative work a striking illustration of the size and weight of a cubic foot of wood. Used also to advantage in density demonstrations.
Built up in sections to prevent warping and cracking, weight neatly printed in large type on one face **7.65**



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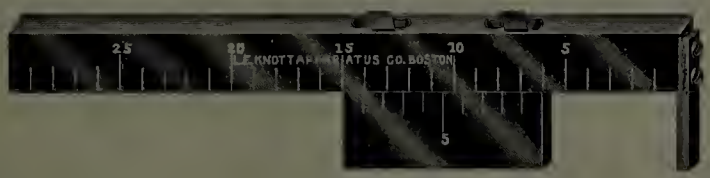
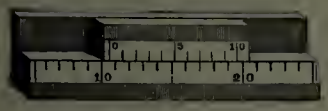
10-60 COMPARATIVE DENSITY WOODEN CUBES, admirably adapted for work in density, offering also objects for simple measurements.
A set of eight cubes, each accurately 4 centimeters on an edge and each of different woods as follows: mahogany, satinwood, poplar, oak, boxwood, walnut, ebony, and lignum-vitæ. Per set, in cardboard case **$3.30**



No. 10-75



No. 10–70

No. 10-80

10-65 CARDBOARD STRIP after Turner and Hersey (Exp. M011) for study of principle of a vernier caliper **$0.10**

10-70 LECTURE ROOM VERNIER MODEL for demonstration and study of simple vernier. Model has total length of 50 centimeters and is divided into 25 spaces of 2 centimeters each. Divisions and figures are clearly defined and large and may be seen across the ordinary lecture room.
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10-75 LECTURE ROOM VERNIER CALIPER MODEL for demonstrative and quantitative work.
This Caliper Model is 30 centimeters long with graduations to centimeters. It is sufficiently accurate for most simple measurements, for the vernier will give readings to 1 millimeter.
Made of clear grain boxwood neatly finished, metal slides nickel plated **2.95**

10-80 LECTURE ROOM VERNIER ARC MODEL, demonstrating principle of vernier arc in angle measurements.
This model is substantially made of hardwood with arc of 25 centimeters radius, vernier slides smoothly and graduations are clearly and accurately made **9.00**

No. 10–85

10-85 SQUARE COMPARATIVE METER STICK for teaching the general principles of linear measure in the Metric System. This stick is a full meter in length and has a cross section measurement of 2 centimeters. First side is graduated into centimeters and millimeters; second, into centimeters only; third, into decimeters only; fourth, ungraduated. The second and third sides have further feature of having spaces painted alternate black and white **$1.50**

10-87 METER STICK (School Meter), of maple, 2 cm. square. One surface plain showing simple meter; second face graduated to tenths or decimeters; third, to hundredths or centimeters; fourth, to thousandths or millimeters with divisions showing also decimeters and centimeters. Not painted as No. **10-85** . . . . . **.68**

No. 10–100

10–100 **BURNISHED COPPER LIQUID MEASURES** for quantitative measures of capacity and for illustrative teaching of units of capacity in the metric system.
Consists of seven measures, — one liter, and fractional parts of liter as follows: ½ liter, 2 deciliters, 1 deciliter, ½ deciliter, 2 centiliters, and 1 centiliter.
Made of burnished copper **$4.90**

10–105 ——, consisting of liter, deciliter, and centiliter measures.
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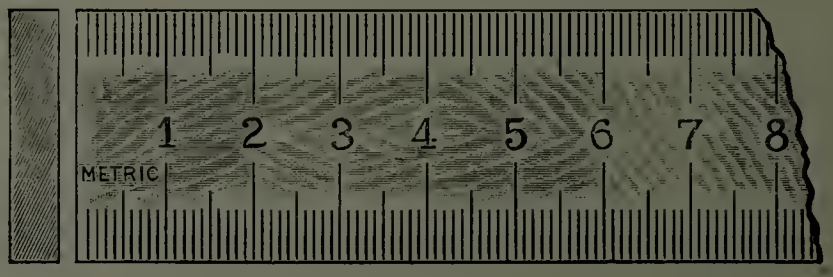
10–125 **WOOD DRY MEASURES,** ½ bushel to 1 quart, 5 pieces **1.45**

MEASURES OF LENGTH



No. 11–10

11–10 **METER STICK** of maple wood. Divided one side into fractional parts of foot and inch to ⅛ inch; other side into fractional parts of meter and centimeter to millimeters **$0.28**

11–10A **METER STICK** with **SET SCREW** and **SLOT** after Turner and Hersey (Exp. **M151**) . . . . . **.38**

11–11 ——, same as **No. 11-10,** but with ends tipped with brass . . . . . **.35**

11–15 **HALF-METER STICK,** same quality as No. **11–11.** Tipped with brass . . . . . **.24**

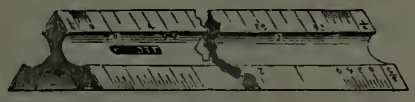
11–20 **DOUBLE-METER STICK,** same quality as No. **11–11.** Tipped with brass **1.35**

11–40 **TEN CENTIMETER METRIC RULE** of maple. This is a convenient 10 centimeter length cut from a meter stick and will be found of great utility in many experiments . . . . . **.07**

No. 11–50

11–50 **DOUBLE BEVEL BOXWOOD RULE,** Metric and English Scales, with ¼ inch blank ends. On Metric bevel 30.5 centimeters are divided to millimeters; on English, 12 inches to sixteenths. Rule is 12½ inches long, ⅞ inch wide, and 3/16 inch thick. Excellent quality . . . . . Each **$0.12**
Per doz. **1.40**

11–55 **DOUBLE BEVEL MAPLE RULE,** Metric and English Scales as in No. **11–50** . . . . . Each **.04**
Per doz. **.40**



No. 11-65

No. 11-70

11-65 TRIANGULAR BOXWOOD RULE AND SCALE, indispensable for rapid drawing to scale or in calculating actual dimensions from scale drawings.

This Rule and Scale has the merit of having six different surfaces for graduation, and there are offered ten different scales to the foot: 3/32, 3/16, 1/8, 1/4, 3/8, 1/2, 3/4, 1, 1½, and 3 inches to the foot. One edge graduated to sixteenths of an inch.

Made of boxwood, hand polished, 12½ inches long with ¼ inch blank ends . . **$0.55**

11-70 VERTICALLY MOUNTED RULE. Used frequently with indicating lever in bending experiments . **$0.16**

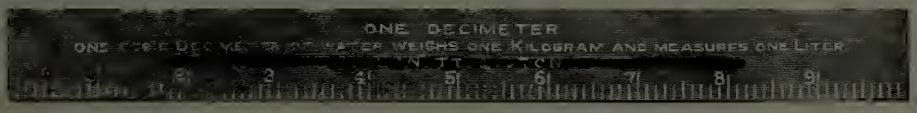
11-80 STRAIGHT-EDGE RULE, especially designed for the drawing of diagrams; useful in light experiments and many other experiments, chiefly in Mechanics.

Made of light, clear-grain selected stock . . . . . Per Pair **.16**

No. 11-100

11-100 STANDARD STEEL RULES, Metric and English Scales subdivided with greatest care and accuracy. The 5 and 10 centimeter rules listed are divided as follows: first corner graduated to ½ millimeter; second, to 1 millimeter; third, to 1/64 inch; fourth, to 1/100 inch. The remaining listed rules: first corner, to ½ millimeter; second, to 1 millimeter; 2 inches of third, to 1/64 inch, the remainder to 1/16 inch; 2 inches of fourth, to 1/100 inch, the remainder to 1/50 inch.

	a	b	c	d	e	f
Length	5	10	20	30	50	100 centimeters
Each	**$0.30**	**.55**	**1.00**	**1.35**	**2.25**	**7.50**



No. 11-105

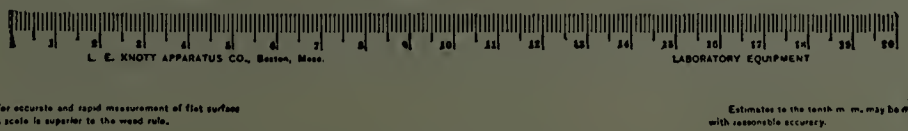
11-105 POLISHED STEEL DECIMETER RULE, "A Key to the Metric System." This rule is "one millimeter thick, one centimeter wide and one decimeter long. Its volume is one cubic centimeter. Its weight in grams is the specific gravity." One side is graduated to millimeters and centimeters. There is also the statement that "one cubic decimeter of water weighs one kilogram and measures one liter."

Each rule sent in metal-bound leather case **$0.58**

No. 11-130

11-130 CELLULOID RULE, Metric and English, 6 inches long, with distinct black-filled accurate divisions showing clearly on the white celluloid.

The adaptability of these rulers as book markers and to the vest pocket and their flexibility to manifold usage has fully warranted their popularity . . . . Each **$0.05** Per doz. **$0.60** Per 100 **$4.25**

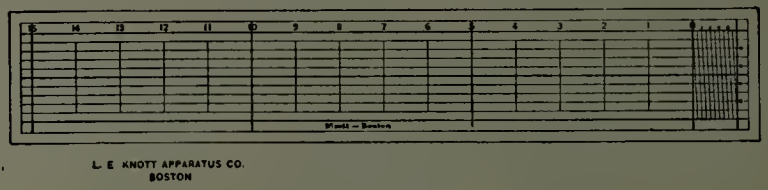

L. E. KNOTT APPARATUS CO., Boston, Mass.
LABORATORY EQUIPMENT
For accurate and rapid measurement of flat surfaces this scale is superior to the wood rule.
Estimates to the tenth m m. may be made with reasonable accuracy.

No. 11-135

11-135 BRISTOL BOARD METRIC RULE, generally useful but especially adapted to measuring curved surfaces.

Twenty centimeters long, graduated to millimeters with margin of about 20 millimeters on either end.

Per doz. **$0.15.** Per 100 **$0.90**



No. 11–140

11–140 **BRISTOL BOARD DIAGONAL SCALE,** very carefully divided, will read accurately to 1/10 millimeter.
Length 16 centimeters . . . . . Each **$0.02**
Per 100 **1.40**

No. 11–145

11–145 **BRISTOL BOARD COMPARING SCALE** for rapid determinations of Metric and English linear equivalents.
Fifty centimeters long, engine divided **$0.28**

11–160 **PAPER METRIC RULE,** 20 centimeters long, same as No. **11–135,** but of heavy bond paper . Per 100 **.67**

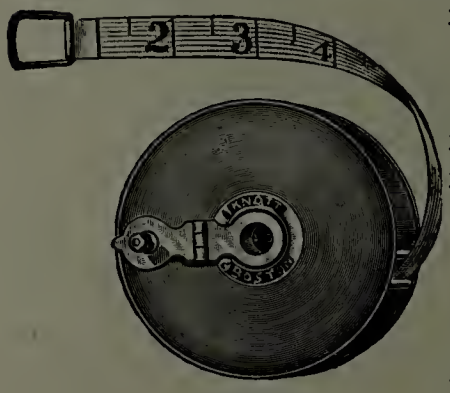
11–165 **PAPER METRIC SCALE,** 100 centimeters long, graduated to millimeters. Accurately printed on heavy bond paper. . . . . Each **.07**

No. 11–175

11–175 **STANDARD METER,** graduated throughout entire length to millimeters, attaining highest possible accuracy at 18 degrees Centigrade.
Graduated on brass and included in neat case . . . . . Duty Free **$30.00**

11–177 **STANDARD METER.** Same as No. **11–175,** one decimeter graduated to millimeters, remainder to centimeters.
Including neat case. . . . . Duty Free **21.50**

11–185 **FOLDING STEEL POCKET RULE,** Metric and English Scales, engine divided, polished surface with black, distinct figures and graduations. Graduated to millimeters on one side, to inches and sixteenths on the other.
Length one foot, 3/8 inch wide, No. 28 gauge steel, folding to 4 inches.
Enclosed in metal-bound leather case. . . . . **.50**



No. 11–220

11–215 **STEEL POCKET MEASURING TAPE, METRIC AND ENGLISH,** spring wind, with stop, German silver case. Graduated to inches and sixteenths on one side, to millimeters on the other. Length 1 meter. . . . . **.95**

11–216 ——, same as above, but 5 meters long **4.25**

11–220 **LINEN POCKET MEASURING TAPE, METRIC AND ENGLISH,** waterproof-coated 1/2 inch corded tape, in brass-bound case with brass folding handle, brass ring and trimmings.
Marked feet and inches one side; meters and centimeters other side. Length 10 meters . . . . . **.67**

11–221 ——, same as above, but 25 meters long **1.35**

MEASURING INSTRUMENTS

Calipers, Micrometers, Verniers, Spherometers, Gauges, etc.

Nos. 12–10 to 12–11

Nos. 12–25 to 12–26

Nos. 12–27 to 12–28

12–10 **COMBINATION, OUTSIDE AND INSIDE CALIPERS,** polished steel. Length 4 inches **$0.20**

12–11 ——, same as above, but 6 inches long . . . . . **.25**

For other Calipers see Index.

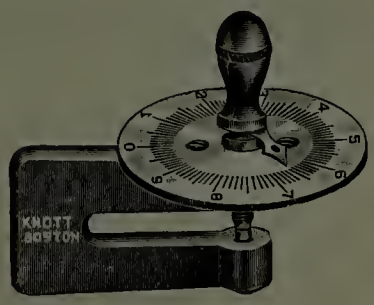
12–25 **OUTSIDE SPRING CALIPER,** extra quality polished steel machinist's caliper. Length 4 inches . . **.80**

12–26 ——, same as above, but 6 inches long . . . . . **.90**

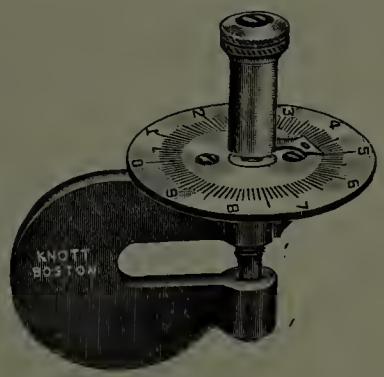
12–27 **INSIDE SPRING CALIPER,** extra quality polished steel machinist's tool. Length 4 inches . . . . **.80**

12–28 ——, same as above, but 6 inches long . . . . . **.90**

Nos. 12-35 to 12-36



No. 12-95



No. 12–97

12–35 **SPRING GAUGE CALIPER,** indispensable for the measuring of thicknesses of lenses, sufficiently accurate for ordinary laboratory measurements of sheet metal and wire. Rapid and accurate, reading directly to 1/10 millimeter. Measuring up to 10 millimeters **$1.60**

12–36 ——, same as above, but measuring up to 14 millimeters **1.95**

12–40 **CALIPER GAUGE** for measuring thickness of plates, boards, etc., within range of 1/40 to 1 7/8 inches, the range of the caliper. Slide rod is graduated on opposite sides, one side reading 32ds, the other 40ths of an inch. All readings are made from the top of the knurled friction slide, and when in operation the contact ends of the gauge are brought together against the object being measured, the measuring rod may be removed from the hook part and the whole taken to the light and the correct measure indicated above the friction slide easily taken **2.50**

12–42 ——, same as above, but graduated in Metric System. Capacity 47 millimeters, rod graduated on one side into millimeters, on the other into 1/2 millimeters **2.60**

12–95 **LARGE DIAL MICROMETER CALIPER** for measuring the thicknesses of thin plates, also diameters of wires. This instrument consists of a dial, 45 millimeters diameter, divided into one hundred divisions. The indicator moves with the screw. Will measure thicknesses and diameters up to 5 millimeters by 1/100 millimeter. Handsomely nickel plated **6.65**

12–97 ——, similar to above, but provided with Friction Head **7.15**

Nos. 12-110 to 12-120

12–110 **FRICTION HEAD METRIC MICROMETER CALIPER.** It is graduated to read to 0.01 mm. and will measure up to 25 mm. Frame of drop forged steel nickel finished. The friction head insures that all measurements are made with the same degree of pressure **$3.35**

12–116 **RATCHET STOP METRIC MICROMETER CALIPER,** graduated to read to 0.01 mm. and will measure up to 25 mm. This caliper is similar to above but with compensated speeded screw and ratchet stop **5.00**

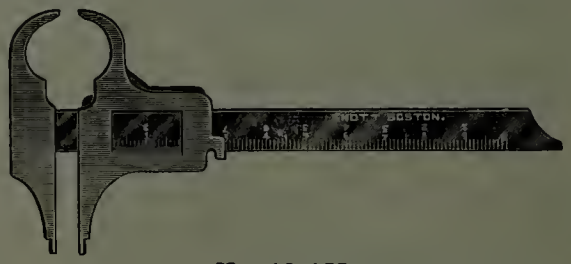
12–118 **RATCHET STOP ENGLISH MICROMETER CALIPER,** same as above but graduated to read to 0.001 inch and will measure up to one inch **5.00**

12–120 **RATCHET STOP DOUBLE MEASURE ENGLISH MICROMETER CALIPER,** similar to above but can be set to read to 0.001 or 0.0001 inch and will measure up to one inch **7.40**

No. 12–140

12–140 **SLIDING CALIPER,** English and Metric measures, of boxwood, with ivory sliding scale. Will measure up to 3 inches by 16ths, or up to 72 millimeters by millimeters. Finer estimations possible **$1.10**

Models for the illustrative demonstration of principle of verniers will be found listed in Section **10.** *For accurately working model of Vernier Caliper see No.* **10-70.**



No. 12–155

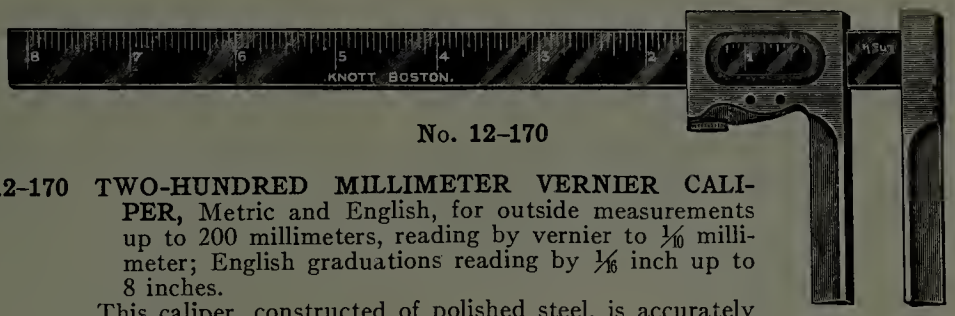
12–155 **VERNIER CALIPER,** Metric measure, generally useful in outside, inside, and depth measurements. In use as outside caliper either square or caliper jaw may be used. In use as inside caliper, read as for outside caliper and add 2 millimeters for width of the points. In reading for depth measurement use upper row of figures and other end of vernier. Range 0 to 10 centimeters.
Made of polished steel **$2.15**

No. 12–160

12–160 **VERNIER CALIPER,** Metric and English measures with verniers for each. Outside, inside and depth measurements each possible with great accuracy. Will measure objects up to 10.7 centimeters by $\frac{1}{10}$ millimeter, or up to $4\frac{1}{4}$ inches by $\frac{1}{128}$ of an inch.
Made of polished steel and provided with thumb knob and set screw **$2.20**

12–161 ——, same as above, in neat leather case **2.45**

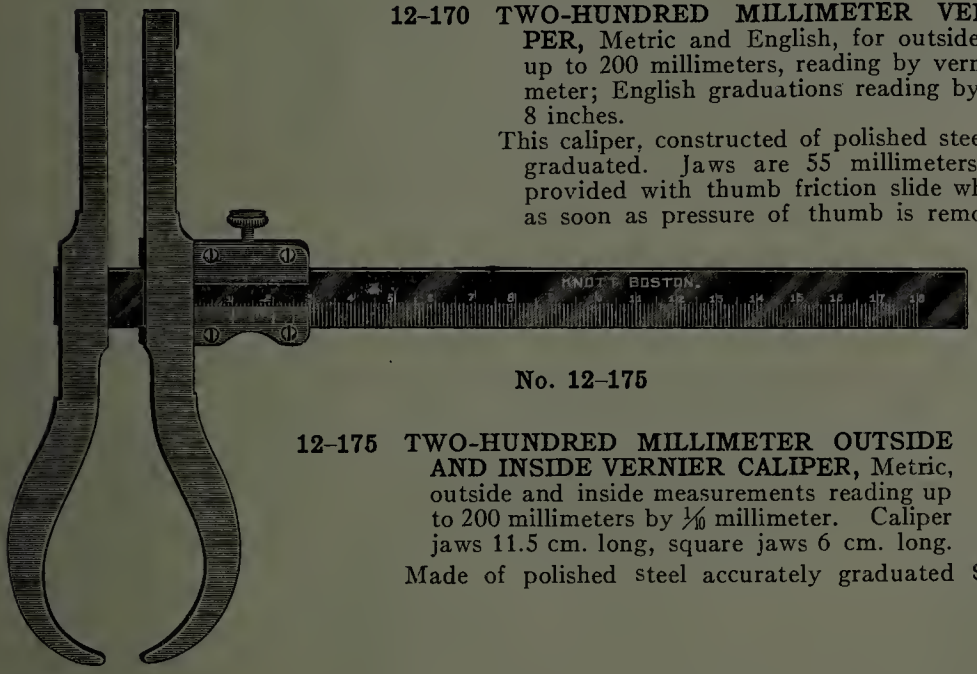
12–165 ——, same as No. **12–160,** but with addition of micrometer screw adjustment. In neat leather case **3.70**



No. 12–170

12–170 TWO-HUNDRED MILLIMETER VERNIER CALIPER, Metric and English, for outside measurements up to 200 millimeters, reading by vernier to 1/10 millimeter; English graduations reading by 1/16 inch up to 8 inches.

This caliper, constructed of polished steel, is accurately graduated. Jaws are 55 millimeters long, the movable one provided with thumb friction slide which binds automatically as soon as pressure of thumb is removed **$4.60**



No. 12–175

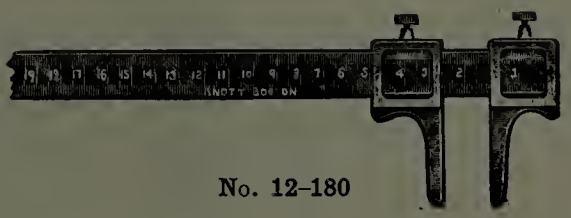
12–175 TWO-HUNDRED MILLIMETER OUTSIDE AND INSIDE VERNIER CALIPER, Metric, outside and inside measurements reading up to 200 millimeters by 1/10 millimeter. Caliper jaws 11.5 cm. long, square jaws 6 cm. long.

Made of polished steel accurately graduated **$4.90**

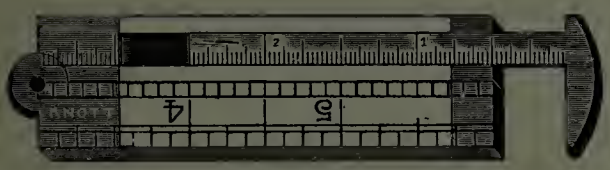
12–180 METER ROD CALIPER ARMS WITH VERNIER, Bonnell design, for use with Meter Stick in assembling a Vernier Caliper of large range.

These arms are smooth metal castings made to fit the standard Meter Stick. One arm is designed for setting at some point arbitrarily selected as the zero of the Meter Stick, while the other carries two verniers, one to read to 1/40 of an inch on the English side, the other to read to 1/10 millimeter on side with Metric divisions.

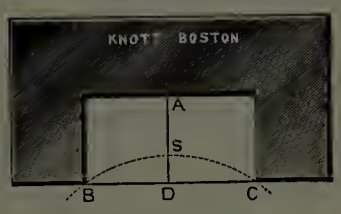
Vernier arms only, neatly nickeled, per pair . . **$2.85**



No. 12–180



No. 12–185



No. 12–190

12–185 CALIPER RULE, for use as a folding pocket rule and caliper. Rapid caliper measurement possible where accuracy not greater than 1/32 inch is desired.

Two fold, brass bound, brass slide, boxwood caliper rule, slide graduated to 1/32, rule to 8ths, 10ths, 12ths, and 16ths of an inch. Total length possible, 6 inches **$0.45**

12–187 ——, same as above, but four fold and 12 inches long . . . . . **.55**

12–190 CYLINDROMETER for measuring diameters of spheres and cylinders from 4 centimeters upwards. With directions . . . . . **.90**

10–75 VERNIER CALIPER MODEL for demonstrative and quantitative work.

This Caliper Model is 30 centimeters long with graduations to centimeters. It is sufficiently accurate for most simple measurements, for the Vernier will give readings to one millimeter.

Made of clear grain boxwood, neatly finished, metal slides, nickel plated. For illustration, see Section **10** **2.75**

No. 12–205

No. 12–210

12–205 **SPHEROMETER** for measuring curvature of lenses, mirrors, etc. Steel screw accurately 1 millimeter pitch, silvered brass head 2 inches in diameter graduated into 50 parts. Legs cover surface of 25 millimeters radius. Will measure surfaces of 5 millimeters concavity or convexity. Reads directly to 1/50 millimeter, but as divisions on head are approximately 3 millimeters apart, estimations to 1/200 are readily possible **$5.90**

12–210 **SPHEROMETER,** inexpensive, serviceable form, reading directly to 1/100 millimeter. Concave measurements to 5 millimeters, convex up to 15 millimeters **3.30**

Showing front view of attachment

No. 12–225

Patent Pending

Showing rear view of attachment

12–225 **HARCOURT UNIVERSALLY-ADJUSTABLE T-BEAM MICROMETER SCREW** for general application in laboratory practice where a micrometer screw is needed.

The above illustration represents a form of Micrometer Screw originated by us for attachment to our No. **5–1000** Harcourt Universal T-Beam Clamp "A". This attachment consists of a casting carrying a swiveled overhanging bracket holding in split-post tension an accurately threaded millimeter screw. The whole is so designed as to permit facing of the screw in either direction and turning the screw in any position in a vertical plane, and a back-and-forth adjustment on the bed of the Basic Clamp. In any of these positions the attachment, screw, and Basic Clamp may be interlocked by the nickel-plated T screws as one rigid instrument.

The Head of the screw is 45 millimeters in diameter and is divided into 100 parts. The Screw is accurately threaded 1 millimeter pitch, thus making possible a reading to 1/100 millimeter.

HARCOURT UNIVERSALLY-ADJUSTABLE T-BEAM MICROMETER SCREW, complete as illustrated, including Micrometer Screw Attachment and No. **5–1000** Harcourt Universal T-Beam Basic Clamp "A" **$4.15**

5–1075 **HARCOURT UNIVERSALLY-ADJUSTABLE MICROMETER SCREW ATTACHMENT,** illustrated above in connection with No. **12–225** **3.25**

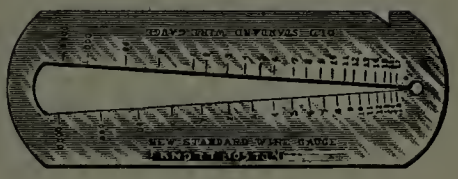
5–1000 **HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "A",** illustrated above in connection with No. **12–225** . . . . . **.94**

12–230 MOUNTED MICROMETER SCREW. This is a carefully designed instrument. The Stand is massive, provided with three milled legs insuring stability and a position in true plumb with the plane of the table. The Screw is accurately threaded 1 millimeter pitch and is provided with a head 45 millimeters in diameter divided into 100 parts, thus reading to 1/100 millimeter. It is mounted in a split-post tension in an overhanging bracket. Binding screw is provided for electrical connection. Handsomely finished throughout **$2.90**

No. 12–230

No. 12–275

Front Side No. 12–280



Reverse Side No. 12–280

12–275 AMERICAN STANDARD WIRE GAUGE, made of best steel, tempered, adjusted and warranted accurate. Decimal equivalents expressed in thousandths, stamped on back opposite regular gauge numbers. Sizes 0 to 36 . . . . . **$2.90**

12–277 ——, same as above, sizes 5 to 36 . . . . . **2.20**

12–280 POCKET SCREW AND WIRE GAUGE for measurements of wire as well as machine and wood screws. On front side of left of slot, this gauge is graduated to show all sizes of the American Standard Screw Gauge from 0 to 30; on other side of slot, equivalent fractions of an inch are marked. The edge of the gauge is graduated to 32ds and 16ths. The back side is graduated on right of slot from 17 to 0000 as the old or English wire gauge; on the left from 15 to 0000 as the new or American wire gauge. The angle cut in the side allows the head of a screw to be placed in a positive stop when measuring the length **2.95**

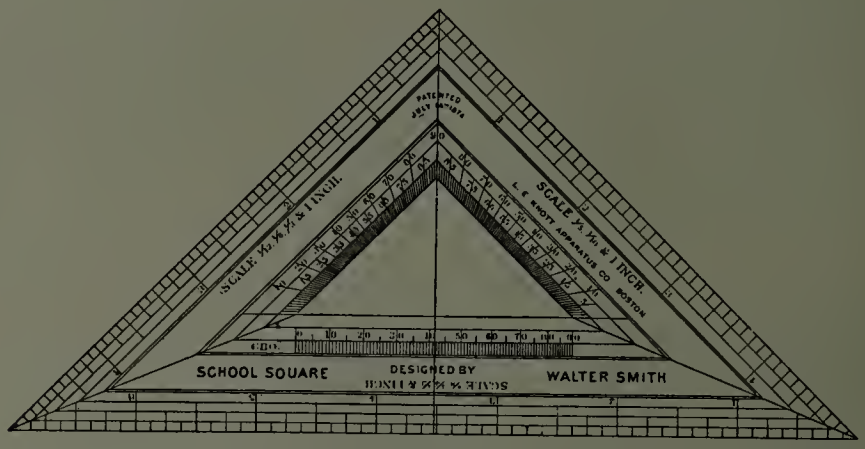
No. 12–295

12–295 POLISHED STEEL INSIDE TAPER GAUGE for inside measurements of tubes, holes, etc. Made of hardened polished steel and about 18 centimeters long; will measure from 1/16 to 15 millimeters . . **$0.80**

No. 12—300

12–300 POLISHED STEEL OUTSIDE TAPER GAUGE for outside measurements of rods, etc. Made of polished hardened steel about 15 centimeters long; will measure all diameters from 1/16 to 10 millimeters **$1.95**

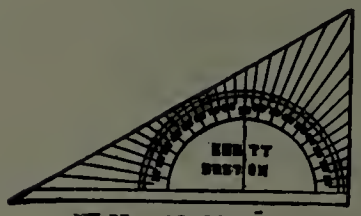
SQUARES AND PROTRACTORS
SLIDE RULES



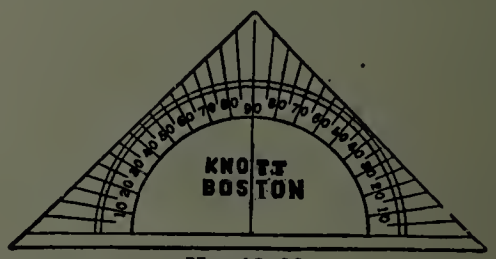
No. 13–10

13–10 WALTER SMITH SCHOOL SQUARE. This instrument, simple in design, neat in appearance, and universal in its varied applications as rule, square, and protractor, has from its popularity of 35 years' unquestioned utility become a standard laboratory instrument.

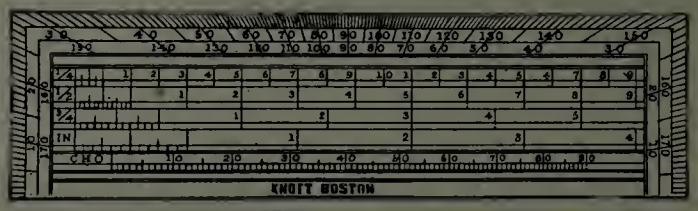
	a	b	c
Length, inches	7	8	10
Each	**$0.06**	**$0.08**	**$0.12**



No. 13–20



No. 13–22



No. 13–30

13–20 PROTRACTOR TRIANGLE, Transparent, 30 and 60 degree angles, long leg 5 inches, divided to 1 degree **$0.60**

13–22 ——, same as above, but 45 degree angles . . . . . **.75**

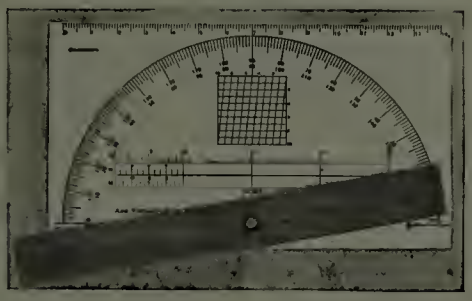
13–30 SQUARE PROTRACTOR, Ivory, 6 × 1¾ inches, graduations to single degrees, scales of ¼, ½, ¾, and 1 inch to the foot, scale of chords, and diagonal scale **2.10**

13–35 SQUARE PROTRACTOR, Boxwood, otherwise same as No. **13–30** . . . . . **.45**

No. 13–50

13–50 COMBINATION BEVELED PROTRACTOR, RULE, and **SQUARE,** protractor engine-divided to 90 degrees, care being taken to insure that the zero is accurately at right angles to the face of the head. An accurately graduated, hardened, 12-inch adjustable rule passes through the revolving turret and may be clamped at any point by means of the thumb nut. A small level attached to one side of the head is adjustable to show any degree.

The utility of this combination instrument is unquestioned and its purchase will never be regretted . **$3.45**

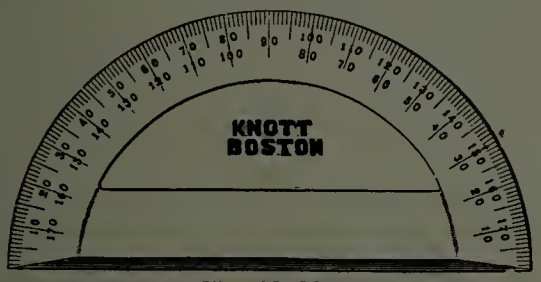


No. 13-75

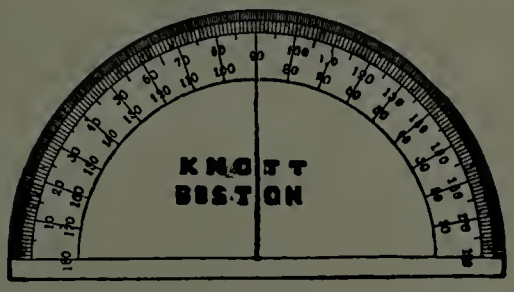
13-75 **PENFIELD ARM PROTRACTOR AND GONIOMETER** for use as a rule, protractor and diagonal scale. As a rule will measure to millimeters up to 14 centimeters; as a protractor to hundredths of an inch. It is an accurate goniometer for measuring plane angles. All graduations are engine divided and all parts carefully and accurately assembled. Complete with directions $0.66

13-76 **PENFIELD CONTACT GONIOMETER** for measuring angles of crystals. Similiar to above but with the protractor arm opaque for a portion of its length. Complete with directions 66

13-77 **PENFIELD CONTACT GONIOMETER** for measuring internal angles. Complete with directions. .66



No. 13-90



No. 13-100

13-90 **BRASS PROTRACTOR,** a good serviceable protractor, 3¾ inches in diameter, graduated in single degrees $0.12

13-92 ——, engine-divided, best quality, 4¼ inches in diameter, graduated in single degrees 27

13-94 ——, engine-divided, best quality, 5⅛ inches in diameter, graduated in ½ degrees 48

13-96 **GERMAN SILVER PROTRACTOR,** best quality, 4¼ inches in diameter, graduated in single degrees 48

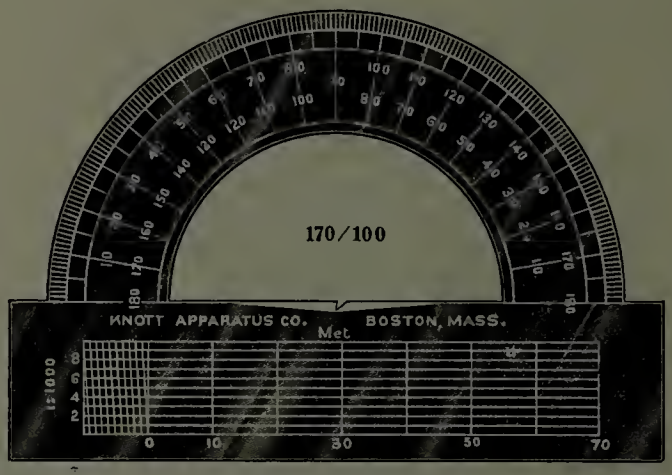
13-98 ——, best quality, 5⅛ inches in diameter, graduated in ½ degrees 72

13-100 **TRANSPARENT AMBER PROTRACTOR,** semi-circular, solid, graduations and figures stamped from engine-divided plate, and clearly shown in black.

	a	b	c	d
Graduations in	1	½	½	½ degree.
Diameter	4	5	6	8 inches.
Each	$0.18	.40	.85	1.35

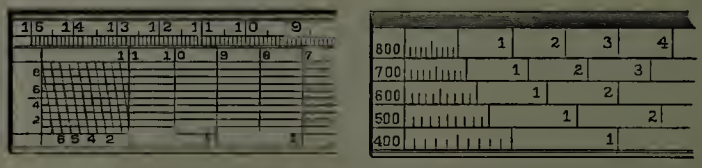
13-105 **BRISTOL BOARD PROTRACTOR,** printed from engine-divided plate, diameter 4 inches, graduated to single degrees, figures reading from each end . . . . . Per doz. .45

13-107 ——, similar to above, but 5 inches in diameter and graduated to ½ degree 12



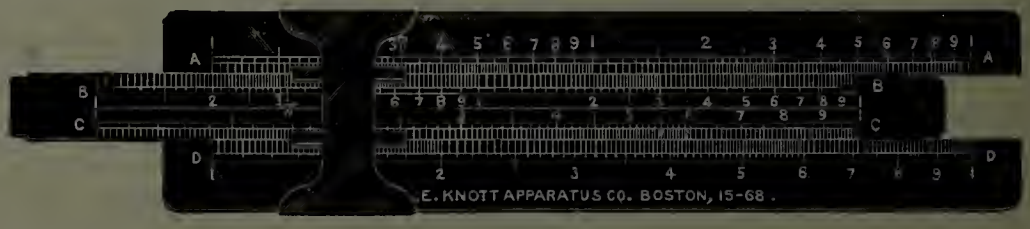
No. 13–135

13–135 **COMBINATION PROTRACTOR AND DIAGONAL SCALE,** brass, silver-finished, 5⅛ inches long, graduations in single degrees, figures reading both directions. Diagonal scale reading 8 centimeters by ⅒ millimeter **$0.54**



No. 13–160

13–160 **METRIC DIAGONAL AND PLOTTING SCALE** of boxwood, 15 centimeters long. One side, double diagonal scale, — one ruled square of 2 centimeters width; the other square, 1 centimeter width, thus allowing measurements up to 15 centimeters by 1/100 millimeter with one and by 1/50 millimeter with the other. The reverse side is divided as a plotting scale, having reduction scales of **1:4, 1:5, 1:7, 1:8,** and **1:9** **$0.10**



No. 13–175

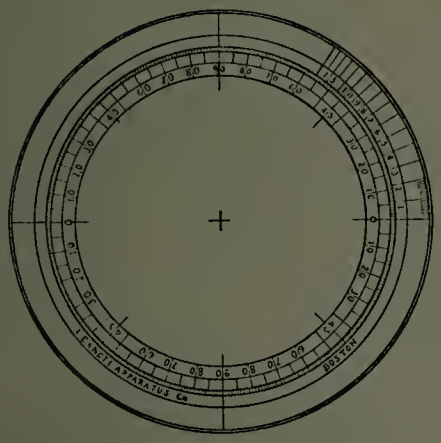
13–175 **STUDENT'S SLIDE RULE** for performing arithmetical computations mechanically, — multiplication, division, squares, and square roots, ratio, etc. All are possible with accuracy to three figures. This rule is made of the best quality of hard, gloss-finish bristol board, is 5 inches long, with letters, figures and graduations neatly and distinctly shown **$0.75**

13–180 **MANNHEIM'S SLIDE RULE,** graduations on white paper with protective coating, transparent indicator in metal frame. 10 inches long. With simple directions **1.40**

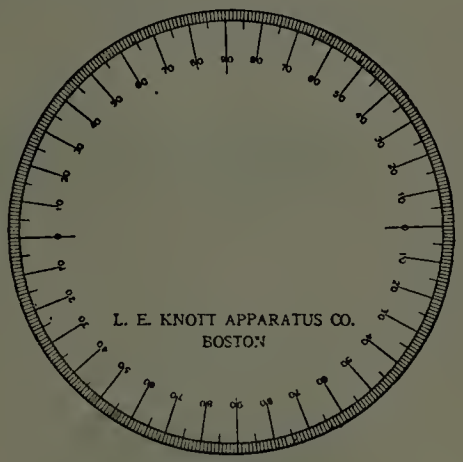
13–185 **SLIDE RULE WITH MAGNIFYING LENS ATTACHMENT,** highest quality imported computing rule with prominent qualities which recommend it wherever a rapid, accurate, and simple scale is desired. Besides an extreme accuracy of parts and graduation, this rule is substantially constructed of mahogany and inlaid with celluloid. Results are obtained directly, without mental effort and without computations.

	a	b	c
Length	25	36	50 centimeters.
Duty Free . . .	**$4.35**	**$9.85**	**$14.65**

CIRCULAR PROTRACTORS, DIVIDING ENGINES, LEVELS, PLUMBS



No. 14–10



No. 14–20

14–10 **WETMORE'S TANGENT SCALE.** This design was suggested by the late Prof. E. W. Wetmore, Normal College, Albany, N. Y. It consists of an engine-divided bristol board dial 3¾ inches in diameter, divided from 0 to 90 degrees in each quadrant to single degrees. On an outer circle tangents of corresponding angles are indicated.

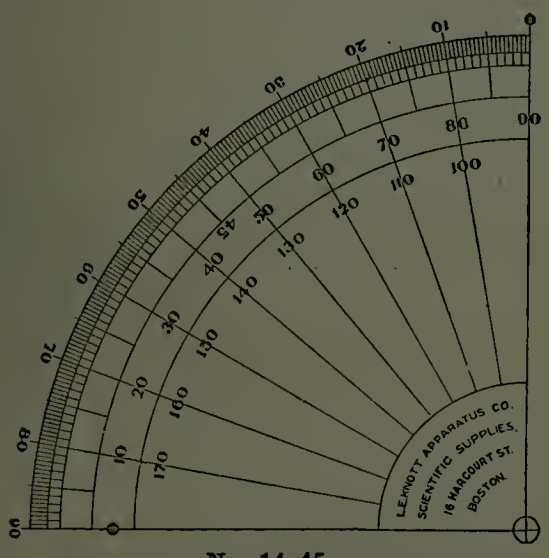
With this dial the tangents of deflection may be noted directly instead of angles themselves, thus current strength may be compared directly without reference to any table . . . . . Each $0.08

14–15 **BRISTOL BOARD CIRCULAR PROTRACTOR,** 13 inches in diameter, with radial lines every 10 degrees and further subdivided on two outer circles to single and to ¼ degrees.

This protractor may be used to advantage in experiments on composition of forces or on torsion Each .50

14–20 **BRISTOL BOARD CIRCULAR PROTRACTOR,** 4 inches in diameter. Graduated in single degrees . . . . . Each .08

14–25 ——, 3 inches in diameter. Graduated to two degrees . . . Each .06



No. 14–45

No. 14–60

14–45 **BRISTOL BOARD QUARTER-CIRCLE PROTRACTOR,** a full quadrant of circle 13 inches in diameter, radial lines every 10 degrees, graduated to single and ½ degrees, figured from 0 to 90 degrees in both directions.

This protractor is used in experiments in torsion $0.09

14–60 **ANGLE-GRAPH** for plotting any angle from 0 to 360 degrees, excellent for plotting protractors.

This instrument consists of a neatly-finished wooden base on which is mounted a brass ring, the upper surface of which is accurately engraved from 0 to 360 degrees. At the geometric center of this circle is fastened a brass rod with projecting screw at its center. An index and sketching arm are held movably about this screw by means of a friction thumb nut.

In use, the card or paper which is to be divided is placed with its central hole over the rod in the central part of the apparatus. By moving the index arm any angle from 0 to 360 degrees may be plotted. Illustration shows the method of making a circular protractor.

As the instrument will take in any size up to 13 inches diameter, it will be found of great convenience in any laboratory 4.90

No. 14–90

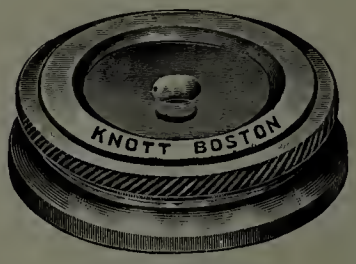
14–90 **CHAPIN-STEPHENS CARPENTERS' STANDARD LEVEL,** first quality of polished cherry with brass arch top-plate and side views. 12 inches long **$0.75**

No. 14–95

No. 14–100

14–95 **WOOD POCKET LEVEL,** first quality, brass top, 5 inches long **$0.40**

14–100 **SOLID ROSEWOOD LEVEL,** extra quality, solid rosewood, brass corners, top-plate, ends and side views. Length 6½ inches **1.50**



No. 14–110

No. 14–115

14–110 **BALANCE LEVEL,** as used on balances and cameras. Will indicate in all directions **$1.00**

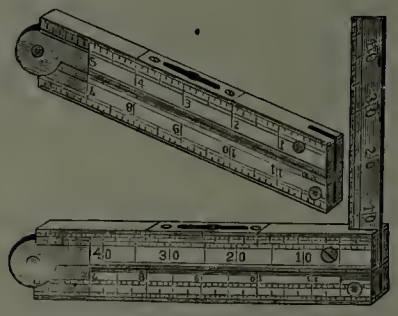
14–115 **TWO-WAY LEVEL AND PLUMB,** valuable in plumbing, squaring, and leveling up work. Leveling is indicated in every way without moving the tool.
Weighs 3 ounces, measures 2 × 3 × ¼ inch thick **1.95**

No. 14–125

14–125 **MERCURY PLUMB BOB,** made from solid steel bored and filled with mercury. Improved by patented slot device for fastening string without tying, also by simple effective device at top for fastening end of string after winding up. Each bob is nickel plated and provided with braided silk line. Weight 6 ounces, length 5 inches, diameter ⅝ inch **$1.65**

14–130 **PLUMB BOB,** iron, black japan finish . . . . . **.12**

No. 14–130



No. 14–135

No. 14–140

14–135 **TWO-FOLD COMBINATION RULE,** comprising in itself a Carpenter's Rule, Spirit Level, Try Square, Plumb, Slope Level, Brace Scale, Draughting Scale, T-Square, Protractor, Right Angled Triangle, and, with a straight edge, a Parallel Rule.
Illustration shows use as a Level and as a Try Square, the upper cut showing steel blade folded like a knife blade into part which holds it.
Made of boxwood, hand-polished finish, well protected with heavy brass binding. Folded, measures 6 × 1⅜ × ⅜ inches **$2.25**

14–140 **POCKET REFLECTING LEVEL,** bronze metal case, 5 inches long. In leather case complete . . . **5.25**

BALANCES AND WEIGHTS

The selection of proper laboratory balances together with appropriate sets of weights for any given laboratory is perhaps one of the most difficult tasks which an instructor is called upon to perform. In the hope that it will be of assistance, we have arranged in tabular form our very complete line of Balances and Weights, dividing them into three arbitrary groups. We believe that if the instructor will consider carefully the kind of work which is to be performed and will then consult the tables, he will be able to determine which balances or combination of balances will secure the best results.

Every laboratory, to be well equipped, should have at least one sensitive Analytical or Assay Balance. Balances of this sort, with the weights to go with them, will be found in Group One. In Group Two, we have included balances of medium grade, that is, — balances of reasonable precision where the utmost accuracy and sensitiveness are not required. Group Three contains miscellaneous balances for heavy and general laboratory work.

In considering the classification given below, it should be borne in mind that it is impossible to draw a hard and fast dividing line between each of the three groups. In making the classification, however, we have been guided by our years' experience in work of this kind, and we have taken the risk of making the experiment in the hope that the tables will be of assistance to teachers who are not familiar with the capacities and sensibilities of the best balances for general scientific work. Detailed descriptions and illustrations will be found on the following pages under the numbers specified in the tables below.

ASSAY AND ANALYTICAL BALANCES

Number	Sensibility
15–10	1/100 mg.
15–20	1/20 mg.
15–27	1/10 mg.
15–30	1/10 mg.

WEIGHTS for above Balances
Nos. 16–10 to 16–100

SCHOOL BALANCES

Number	Sensibility
15–45	1/5 mg.
15–50	1/2 mg.
15–55	1/2 mg.
15–70	1 cg.
15–75	3 cg.
15–80	1 cg.

WEIGHTS for above Balances
Nos. 16–10 to 16–100 and
Nos. 16–150 to 16–180

GENERAL LABORATORY BALANCES

Number	Sensibility	Number	Sensibility
15–100	1/2 cg.	15–130	
15–105	1/2 cg.	15–135	
15–115	1 mg.	15–140	1 cg.
15–120	5 mg.	15–150	1 oz.
15–125	5 mg.	15–160	1/2 cg.
		15–165	1 cg.

HAND BALANCES
Nos. 15–200 and 15–205
Nos. 15–250, Jolly Balance

SPRING BALANCES
Nos. 15–300 to 15–375

WEIGHTS for above Balances
Nos. 16–300 to 16–385

IRON WEIGHTS
Nos. 16–425 to 16–478

BALANCES, ASSAY AND ANALYTICAL

No. 15–10

15–10 HIGH-GRADE ASSAY BALANCE, sensibility $\frac{1}{100}$ milligram, agate edges and planes, enclosed in case.

Beam 19 centimeters long, open construction, made of aluminum alloy possessing a high tensile strength and a uniform density, divided into $\frac{1}{100}$ milligram divisions showing white on black oxidized beam. Edges and Planes are accurately ground from the highest quality stones. Provided with simple Beam Hoist and Pan Arrest. Rider Carriage is operative over full length of beam. Hangers, of usual skeleton type, are made of nickel silver, Pans of aluminum.

Balance is mounted on Double-Drawer Base topped by Black Glass Slab and provided with Leveling Screws. It is enclosed in Polished Mahogany Case with glass front slide, glass sides and top. All parts are handsomely finished with a durable acid-resisting transparent lacquer.

Price from stock, **$110.00**

No. 15–20

No. 15–27

15–20 KNOTT'S HIGH-GRADE ANALYTICAL BALANCE, capacity 200 grams, sensibility $\frac{1}{20}$ milligram, agate edges and planes, enclosed in case.

Beam 18 centimeters long, open truss construction, made of aluminum alloy possessing a high tensile strength and a uniform density, is divided into $\frac{1}{20}$ milligram divisions filled white on the black oxidized beam. Edges and Planes are ground from carefully selected agate of highest quality. Provided with independently operative Beam Hoist and Pan Arrests, the pan arrests being of special design easily controlled and if desired self locking. Rider carriage of simple double-hook pattern has full clear sweep over entire length of beam. Pans and Bows are of nickel silver, the pans being about 5.5 centimeters in diameter.

Balance is mounted on Drawer Base topped by heavy Black Glass Slab provided with sensitive crossed vial Level and Leveling Screws. It is enclosed in Polished French Mahogany Case with front and back glass slides, glass sides and top. It is handsomely and durably finished with an acid-resisting colorless lacquer.

Price from Stock, **$117.50**

15–27 THE "BERLIN" SHORT ARM ANALYTICAL BALANCE, capacity 200 grams, sensibility $\frac{1}{10}$ milligram, agate edges and planes, enclosed in case.

Beam, 15 centimeters long, open construction, is divided into $\frac{1}{10}$ milligram. Simple Rider Carriage operates over half of beam. Agate Edges and Planes carefully ground from selected stones. New, effective Pan and Beam Arrestment operative simultaneously. Bows and Pans made of nickel, pan 5 centimeters in diameter being attached.

Balance is mounted on Black Glass Slab provided with quick-acting Circular Level and Leveling Screws. It is enclosed in Polished Mahogany Case with glass front and back slides, glass sides and top. It is finished with a protective acid-resisting lacquer.

This balance meets all requirements for accurate and rapid weighings.

Price from Stock, **$65.00**

No. 15–30

15–30 HIGH-GRADE ANALYTICAL BALANCE, capacity 100 grams, sensibility $\frac{1}{10}$ milligram, agate edges and planes, enclosed in case.

Beam, 15 centimeters long, open construction, made of aluminum alloy possessing high tensile strength and uniform density, is divided the full length from O at center into $\frac{1}{10}$ milligrams. Edges and Planes carefully ground from the highest quality selected agate.

Independently operative Beam Hoist and Pan Arrest. Simple, single hook Rider Adjustment has full, clear sweep of entire length of beam. Pans and Bows are of nickel, pans, 7.5 centimeters diameter, being attached to bows.

Balance is mounted on Drawer Base provided with quick-acting Circular Level and Leveling Screws. It is enclosed in Polished Mahogany Case with front and back glass slides, glass sides and top. It is Heavily Platinum Plated throughout, thus insuring against corrosion.

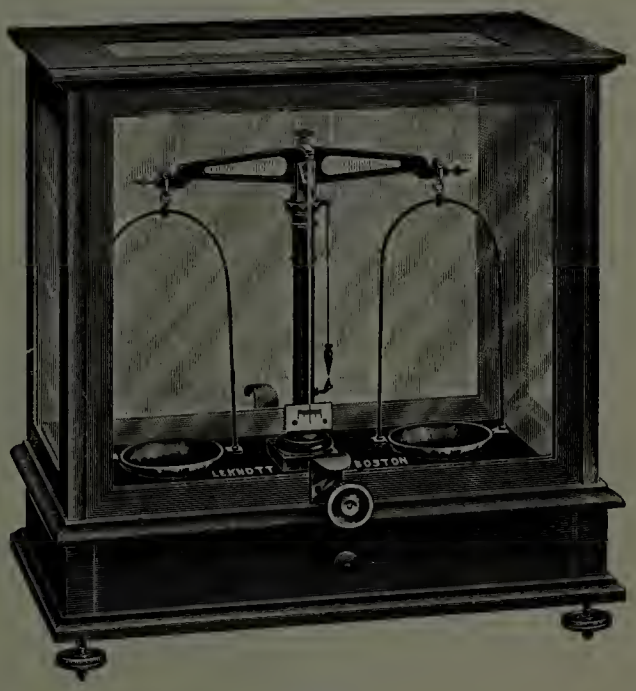
We call especial attention to the quality of the case of this balance. It is of selected mahogany, carefully seasoned and polished to a piano finish.

In that all metal parts are heavily platinum plated, the balance is proof against corrosion. Its durability as an accurate analytical balance is permanently assured.

Price from Stock, **$62.00**

SCHOOL BALANCES

No. 15–45



No. 15–50

15–45 "HARCOURT SPECIAL" QUICK-ACTING BALANCE, capacity 100 grams, sensibility ⅕ milligram, agate edges and planes, enclosed in case.

Beam, 18 centimeters long, open construction, is divided into ⅕ milligrams on one side of central knife edge. Agate Edges and Planes carefully ground from selected stones. Simple Beam Hoist and Rider adjustment. Pans, 8.5 centimeters in diameter, are detachable.

Balance is mounted on Drawer Base, provided with Plumb Bob and Leveling Screws. It is enclosed in Polished Mahogany Case with glass front slide, glass sides, top and back.

This balance was designed especially for us and we have no hesitancy in commending it as combining all the essential qualifications of a high-grade balance at a cost within the range of any educational institution.

Price from Stock, **$42.25.** Duty Free, ...

15–50 KNOTT'S NORMAL BALANCE, capacity 100 grams, sensibility ½ milligram, agate edges and planes, enclosed in case.

Beam, 21 centimeters long, open construction. Edges and Planes of carefully-ground agate. Simple, effectively operating Beam Hoist, detachable 8 centimeter pans.

Balance is mounted on Drawer Base, provided with Plumb Bob and Leveling Screws. It is enclosed in Polished Mahogany Case with front and back glass slides, glass sides and top.

The balance is lacquered throughout and being made especially for us by a noted manufacturer we unhesitatingly recommend its qualities.

Price from Stock, **$35.00.** Duty Free, ...

No. 15-55

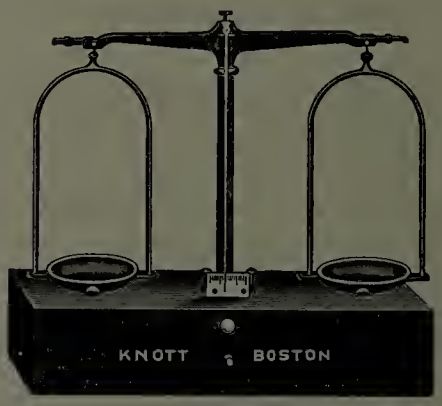
15–55 HARCOURT SCHOOL BALANCE, capacity 50 grams, sensibility ½ milligram, steel edges and planes, enclosed in case.

Beam, 20.5 centimeters long, closed construction. Edges and Planes of steel accurately ground and polished. Simple Beam Hoist. Detachable 6.5 centimeter Pans.

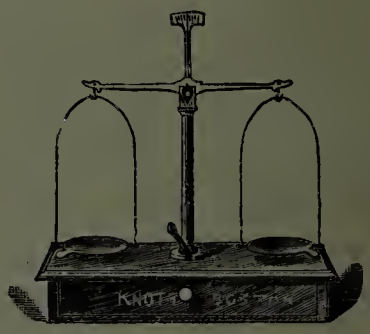
Balance is mounted on Drawer Base, provided with Plumb Bob and Leveling Screws. It is enclosed in Polished Mahogany Case, with glass front slide, glass sides and back, lacquered throughout.

This balance is well made throughout and is dependable in all of its qualifications.

Price from Stock, **$29.50.** Duty Free, ...



No. 15-70



No. 15-80

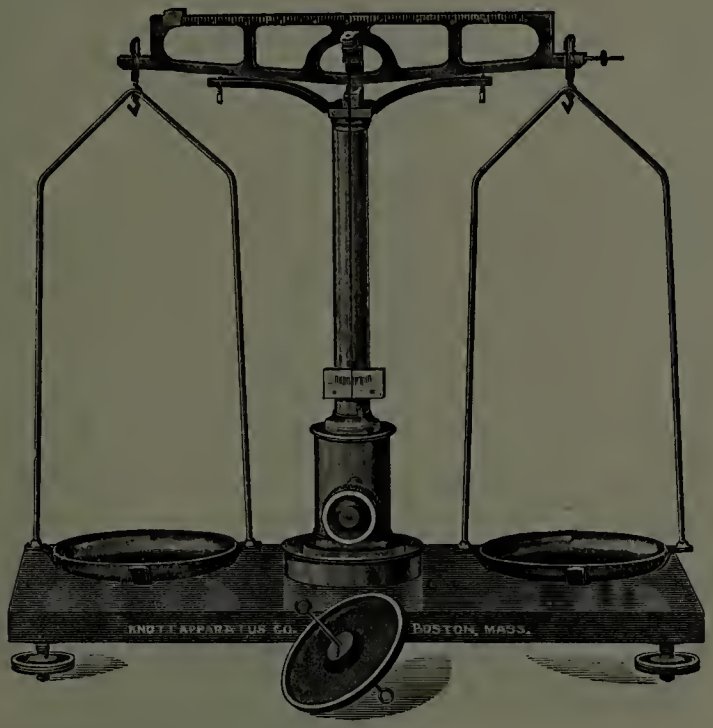
15–70 EQUAL ARM BALANCE, capacity 20 grams, sensibility 1 centigram, polished steel edges and planes, mounted on drawer base.

Beam, 23 centimeters long, closed construction with adjusting screws, is provided with eccentric lift. Pans, 7.5 centimeters diameter. Balance is mounted on Polished Mahogany Drawer Base, is polished throughout, with lacquer and nickel-plate finish **$12.00**

15–75 ——, similar in design to No. **15–70,** but smaller and less sensitive. Beam 15 centimeters long, pans 6 centimeters in diameter, sensibility 3 centigrams **8.50**

15–80 EQUAL ARM BALANCE, reliable for small weighings. Beam 15 centimeters long. Pans 7.5 centimeters in diameter, Lever Lift. Balance is nickel-plated throughout and is mounted on Polished Oak Drawer Base **3.75**

PHYSICAL LABORATORY BALANCES



No. 15–100

15–100 "THE BOSTON" LABORATORY BALANCE, capacity 2000 grams, sensibility ½ centigram, polished steel knife-edges and planes, mounted on polished mahogany base provided with leveling screws.

Beam, 32 centimeters between knife-edges, of open truss construction, is divided entire length, with 0 at the left. Rider of improved design is attached movably to beam. Edges and Planes are of polished steel accurately adjusted. Pans, 14 centimeters in diameter, are detachable from stirrups. Beam Hoist of simple eccentric type, operated by knurled head.

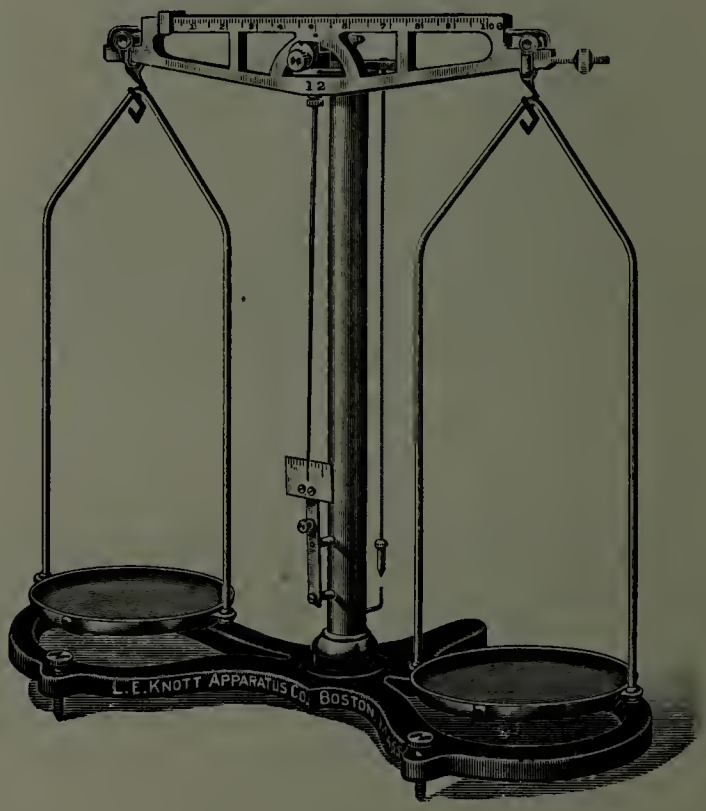
This balance is mounted on highly Polished Mahogany Base provided with Leveling Screws. It is handsomely finished and coated with protective lacquer. Pans are nickel-plated.

Each balance is provided with accurate counterpoise to take place of one of the stirrups when balance is used in hydrostatic work.

Prospective purchasers of a balance of this type will do well to investigate our make before deciding upon another. Our confidence in our product is such that we will gladly offer every facility for comparative tests on

1. Beam stability and uniform density.
2. Careful mechanical construction and, therefore, accuracy and sensibility.
3. Design.
4. Finish.

Price from Stock, **$22.00**



No. 15–105

15–105 THE "BAY STATE" LABORATORY BALANCE, capacity 2000 grams, sensibility ½ centigram; polished steel knife-edges and planes, mounted on substantial metal base.

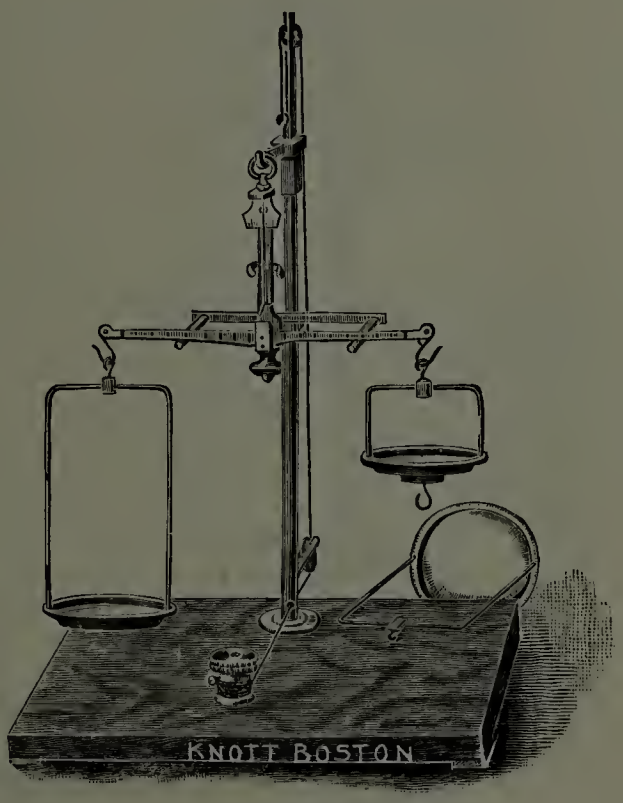
Beam, 32 centimeters between knife edges, of open truss construction, is divided the entire length from 0 at the left. Improved rider is attached movably on beam but cannot be detached. Edges and Planes are of polished steel. Pans, 14 centimeters in diameter, are detachable from stirrups.

The support for this balance consists of a neatly japanned metal base to which is mounted a nickel-plated upright which carries the beam. This upright is provided with a damper, which, operated by a thumb screw, dampens the vibrations that rapid readings may be taken. A plumb bob fastened to the upright, and leveling screws in the base, afford ample adjustments for leveling.

Each balance is furnished with an adjustable shelf for work in hydrostatics.

Price from Stock, **$14.35.** Duty Free, ...

No. 15–115



No. 15–125

15–115 SPECIFIC GRAVITY BALANCE, capacity 200 grams, sensibility 1 milligram, polished steel edges and planes. Beam 14 centimeters long, of aluminum alloy. Beam lift, detachable pans 7 centimeters in diameter with removable papier-maché pan linings.

Each balance is mounted as illustrated and is supplied with a Thermometer Plummet (Reimann's patent), two Counterpoises of 10 and 5 gram weight, and with a glass Hydrometer Jar. Duty Free . .

No. 15–120

15–120 WESTPHAL'S SPECIFIC GRAVITY BALANCE, for rapid determinations of specific gravity of liquids up to the fourth place of decimals.

All parts of this balance are most carefully made. In use they are mounted on a polished mahogany box, as illustrated, which serves as a storage and carrying case. Each balance is furnished with an accurate Thermometer (Reimann's patent), Counterpoise, Jar and eight Riders.

Price from Stock . . .
Duty Free . . . . . .

15–125 KNOTT'S HYDROSTATIC BALANCE with **ADJUSTABLY SUSPENDED BEAM.** This balance is made according to our specifications by a well-known European balance maker. Capacity 250 grams, sensibility 5 milligrams, polished steel edges and planes. Beam 25 centimeters long graduated the whole length with zero at the center. Beam hoist consists of pulley and capstan. Three counterpoised stirrups with attached pans are supplied; two stirrups are of the same size and the third, somewhat shorter, permitting with beam raised, a clear space of 23 centimeters below the scale pan. Mounted on polished mahogany base. Duty Free . . .

No. 15–130

No. 15–140

15–130 **HYDROSTATIC BALANCE,** prismatic-steel knife-edges, mounted on japanned, round, iron base. Beam 8½ inches long is supported on polished steel knife-edges on planes held in a stirrup attached to the top of a brass rod which telescopes into a brass tube.

The two pans attached by chains to hooks near the ends of the beam are 4 inches in diameter and are heavily nickel-plated. One pan is suspended by short lengths of chain and is provided with hook for experiments in specific gravity. The beam may be elevated, giving an adjustment of from 6 to 14 inches from the top of the table. This balance will be found satisfactory for experiments in specific gravity. It is of the best workmanship and handsomely finished throughout . . . . . **$ 6.90**

15–135 **SPECIFIC GRAVITY BALANCE,** similar in design to No. **15–130,** but smaller. Beam is 7½ inches long, pans 2½ inches diameter, adjustment of hook possible from 4½ to 10 inches **4.40**

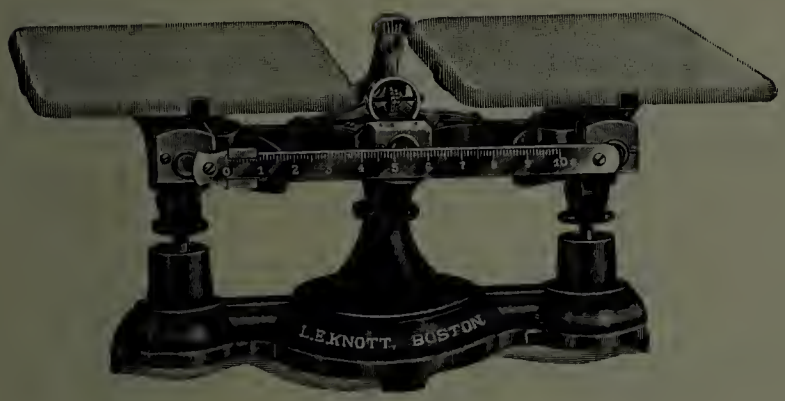
15–140 **TRIPLE BEAM BALANCE,** for rapid and accurate weighings in Physical or Chemical Laboratory. Capacity 111 grams, sensibility (guaranteed) 1 centigram.

As name "Triple Beam" describes, this balance is constructed with three beams so placed one over the other as to secure uniform weight upon the knife-edge. The lower beam has a capacity of 100 grams by 10-gram divisions; the middle beam, 10 grams by single grams; the upper beam, 1 gram by 1/10 and 1/100 gram, each beam carrying an accurately adjusted weight attached movably to it. Base is substantially made of cast iron neatly japanned and is provided with sensitive spirit level and leveling screw. Upright, neatly nickel-plated, carries an adjustable support for the receptacle in specific gravity experiments. At top of upright there is a knurled head which operates a simple lift for beam when not in use. Pan, 10 centimeters in diameter, is detachable. Price from stock **14.00**

15–150 **PLATFORM COUNTER SCALE** for use on a counter or low platform. This scale is the standard platform scale with low pillar. A multitude of uses will be found for it in any laboratory. Capacity 200 pounds by 1 ounce. Platform measures 10½ by 14 inches.

Complete with Weights **$17.50**

No. 15–150



No. 15–165

The form of this Trip Scale is such as to make it the most convenient balance for laboratory work.

DESIGN. The center of gravity of the moving system is properly placed. Made of rigid cast metal, it will stand heavy loads without error. The knife-edges are held rigidly in position and cannot change. The equal length of the arms is absolutely assured.

No. 15–180

NEW FEATURES which have been added are noteworthy in the field of Balance Construction:

METHOD OF READING. By reference to the cut, it will be noted that we have adopted the straight line indicator which eliminates all errors due to parallax.

LONG GRADUATED RIDER ARM. The length of the rider arm has been greatly increased so as to give a wide, open scale with a range of 10 grams in $\frac{1}{10}$ gram divisions.

SPECIFIC GRAVITY HOOK. For convenience in Specific Gravity Experiments, a hook is securely attached to each platform post.

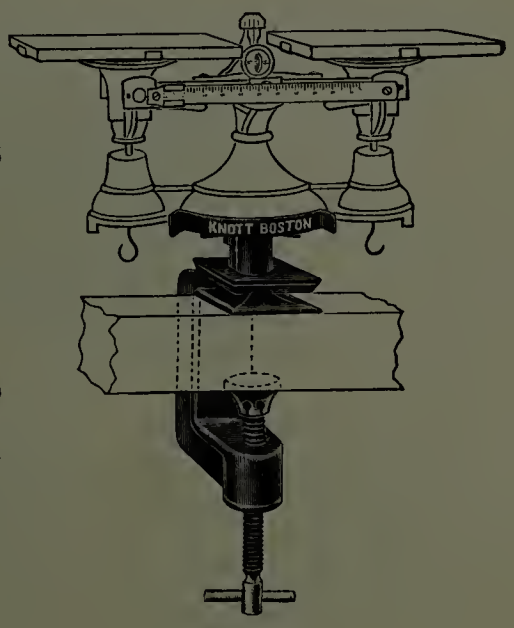
ADJUSTMENT. The position of the adjusting screw is properly placed to avoid accidental displacement.

15–160 STEEL BEARING HARCOURT TRIP SCALE $5.75

15–165 AGATE BEARING HARCOURT TRIP SCALE. This scale, in addition to above important improvements, is provided with six agate planes accurately secured and set in rigid castings. The agate holders are cut with such a degree of nicety that we are able to guarantee the planes not to loosen or change position even to $\frac{1}{1000}$ of an inch 6.65

15–180 THE HARCOURT INTERLOCKING METAL TRIP SCALE SUPPORT for use on the table with above trip scales in specific gravity experiments.

The design of the various parts of this support is such that danger of balance falling from support or being knocked from same is wholly obviated. The Harcourt Special H-Base is designed so that the 6 × 8 inch battery jar or other containing vessel may be placed directly under the suspending hook. Support only $2.85



No. 15–182

15–182 CROSS BAR T-BEAM ATTACHMENT TRIP SCALE SUPPORT, for use with our T-Beam Basic Clamp No. 5–1150 in supporting the trip scales above to the cross bar of Standard Physics Table No. 1-100. This attachment is readily secured to the No. 5-1150 clamp and permits of use of trip scale crosswise or lengthwise of the table, in addition, enabling one to readily adjust the height of balance from top of table.
Complete without T-Beam Basic Clamp No. 5-1150 . . 1.00

5–1150 HARCOURT T-BEAM BASIC CLAMP "B" as required for use with above attachment 1.65

15–185 WOODEN SPREADER FOR HARNESS, after Turner and Hersey (Exp. M041) 12

15–186 WOODEN COUNTERPOISE, after Turner and Hersey (Exp. M041) 12

15–187 BRASS S-HOOK, after Turner and Hersey (Exp. M041) 08

No. 15-200

15-200 **HAND BALANCE,** first quality standard hand balance, 7½ inch beam, hardened steel knife-edges; horn pans 3 inches diameter; beam, lacquered brass **$2.25**

15-205 ——, similar to above, but less expensive in construction **1.65**

5-915 **HAND BALANCE SUPPORT OR CLAMP** for use on a tripod stand as a support for hand balances, affording a simple but effective method of adjusting the position of the pans to various conditions in experiments in specific gravity. For illustration see Section 5 . . . . . **.28**

No. 15-250

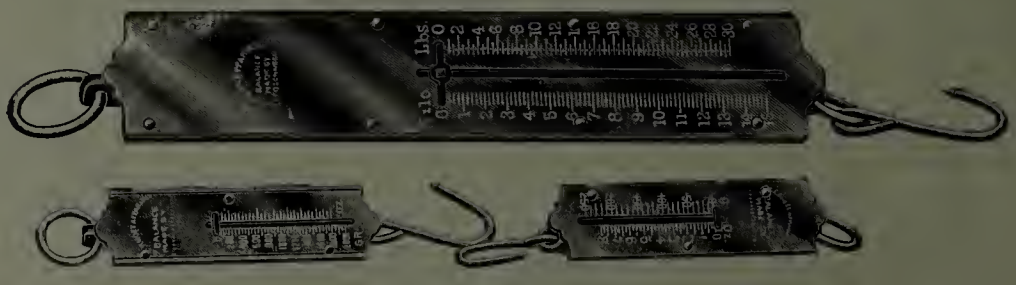
15-250 **IMPROVED JOLLY BALANCE.** This is a design utilizing our No. **22-130** Universal Stand used so extensively in Topic II. To this stand are clamped special clamp castings, one to hold the stirrup to which the spring is attached, another (No. **5-895**) for clamping the mirror scale, another (Platform No. **5-527**) for supporting the glass vessel. The adjustments possible with this structure and the ready adaptability of the various parts to other uses will be noted.

Jolly Balance complete as illustrated, with two aluminum scale pans, plummet, two springs, — one for high and one for low tension, and accessories noted above, except glass vessel **7.85**

15-251 **JOLLY BALANCE SPRING** for low tension . . . . . **.50**

15-252 ——, for high tension . . . . . **.50**

SPRING BALANCES



Nos. 15-300 to 15-315

Our spring balances are constructed for us according to our specifications and we have, therefore, been able to embody important features not found in stock designs. One of our specifications in our orders to the manufacturer is that the tension of the spring must be uniformly accurate. Graduations are distinct and all parts are carefully made throughout. Handsomely finished in nickel and black finish. All our balances have double pointer for accurate readings in both horizontal and vertical positions. In use in vertical position the weight of the hook is automatically deducted by the width of the pointer.

15–300 **FLAT BACK SPRING BALANCE,** double scale, 250 grams by 10-gram divisions, and 8 ounces by ¼-ounce divisions. **$0.80**

15–305 ——, double scale, 500 grams by 20-gram divisions, and 16 ounces by ½-ounce divisions. . . **1.00**

15–310 ——, double scale, 2000 grams by 25-gram divisions, and 64 ounces by ½-ounce divisions. . . **.45**

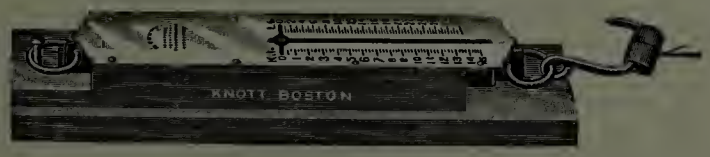
15–315 ——, double scale, 15 kilograms by 200-gram divisions, and 30 pounds by ¼-pound divisions. . . **1.65**

No. 15–332

15–330 **TEN-POUND LABORATORY DYNAMOMETER** in nickel-plated brass tube. English system only, 10 pounds by ¼ pound. Length, exclusive of hook and ring, 3⅜ inches **$1.40**

15–332 **TWENTY-POUND LABORATORY DYNAMOMETER** in nickel-plated brass tube. English system only, 20 pounds by ¼ pound. Length, exclusive of hook and ring, 8 inches **2.15**

15–334 **SIXTY-POUND LABORATORY DYNAMOMETER** in nickel-plated brass tube. English system only, 60 pounds by ½ pound. Length, exclusive of hook and ring, 9½ inches **3.20**



No. 15–365

15–360 **SPRING BALANCE CRADLE,** for holding a spring balance in a flat position. Made entirely of metal for double-scale balances Nos. **15–300** to **15–310** **$0.15**

15–365 ——, same as above, but made entirely of wood for spring balance No. **15–315** . . . . . **.45**

No. 15–375

15–375 **RINTOUL'S SPRING DYNAMOMETER,** open movement, an effectively working spring balance. Consists of the usual form spring resting in a groove, with hook for attaching to scale pan, etc. A double indicator allows reading from scale from 1 gram up to 250 grams, or from ¼ ounce up to 8 ounces, with balance in either horizontal or vertical position. An adjustment at top by which the spring can be reset allows for variations in the zero reading, providing spring should become permanently elongated. Made wholly of metal and handsomely finished in bright nickel and japan **$2.50**

WEIGHTS

STANDARD NORMAL WEIGHTS

The weights under this heading are adjusted, with the utmost nicety attainable, to the standard which has been verified by the "Bureau International des Poids et Mesures" at 0° in vacuo, to an accuracy of 0.01 milligram.

No. 16–10

16–10 STANDARD NORMAL KILOGRAM, constructed of the hardest attainable drawn-brass rod turned to shape, and trimmed by long and tedious work to practical accuracy, the final finest adjustment being then secured by an adjusting pin ground into the top, and a gold plating.
Enclosed in polished mahogany, plush-lined lock case.

Duty Free, **$32.50**

16–15 STANDARD NORMAL GRAM, constructed from a single piece of platinum-iridium, trimmed and adjusted with the same nicety as the above.
Enclosed in polished mahogany, plush-lined lock case.

Duty Free, **$16.75**

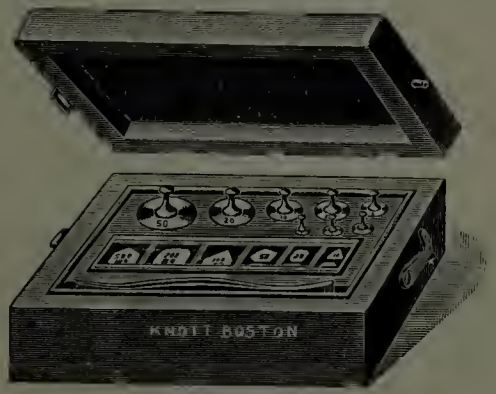
16–20 STANDARD NORMAL WEIGHTS, each weight constructed from the hardest attainable hard-drawn brass rod turned to shape, trimmed and adjusted with the same painstaking accuracy as the above. Fractional weights are of platinum, adjusted to finest possible accuracy. Set from 1 milligram up to 100 grams, enclosed in polished mahogany, plush-lined case.

Duty Free, **$38.00**

PRECISION AND ANALYTICAL WEIGHTS

The following weights, Nos. **16–50** to **16–100,** are adjusted to the highest degree of accuracy. Turned from hard-drawn brass rod, they are more durable than cast weights and much superior from standpoint of permanent accuracy.

No. 16–50



No. 16–70

16–50 **PRECISION WEIGHTS,** gold-plated. Fractional weights 500 to 10 milligrams, are of platinum, the smaller ones of aluminum. One milligram up to 50 grams, with ivory-pointed forceps and camel's-hair brush in velvet-lined, highly polished mahogany case with removable lid.
Price from Stock **$12.00**
Duty Free . . . . . .

16–52 ——, same as above, but 1 milligram up to 100 grams **20.00**

16–54 ——, same as above, but 1 milligram up to 200 grams . . . . . Duty Free . . .

16–70 **ANALYTICAL WEIGHTS,** gold-plated, similar to Nos. **16–50** to **16–54,** but of different, though as accurate adjustment, and enclosed in case of cheaper construction. One milligram up to 50 grams
Duty Free . . .

16–72 ——, same as above, but 1 milligram up to 100 grams . . . . . Duty Free . . .

Nos. **16–80** to **16–100**

16–80 **ANALYTICAL WEIGHTS,** single weights, gold plated, minutely adjusted, as used in sets Nos. **16–70** to **16–72.**

	a	b	c	d	e	f	g	h	i	j
Size, grams	1	2	5	10	20	50	100	200	500	1000
Each . . .	**$0.60**	**$0.75**	**$0.95**	**$1.35**	**$1.60**	**$1.90**	**$2.40**	**$3.10**	**$4.25**	**$5.85**

16–90 **ANALYTICAL FRACTIONAL WEIGHTS,** single weights, — 500 to 10-milligram weights of platinum; 5 to 1-milligram weights of aluminum, as used in sets Nos. **16–70** to **16–72.**

	a	b	c	d	e	f	g	h	i
Size, milligrams	1	2	5	10	20	50	100	200	500
Each	**$0.20**	**$0.20**	**$0.20**	**$0.30**	**$0.35**	**$0.45**	**$0.75**	**$1.10**	**$1.95**

16–100 **ANALYTICAL RIDER WEIGHTS,** single weights of solid gold.

	a	b	c	d	e
Size, milligrams . .	1	2	5	10	12
Each	**$0.40**	**$0.40**	**$0.25**	**$0.25**	**$0.25**

For other **SINGLE WEIGHTS, FRACTIONAL WEIGHTS,** and **RIDERS,** see Nos. **16–350** to **16–370.**

TECHNICAL WEIGHTS

The weights under this heading are intended for technical purposes. They are carefully adjusted, but not to the same degree of accuracy as our Precision and Analytical Weights. Single weights are made of hard-drawn brass rods turned to weights, neatly lacquered and then adjusted.

No. 16-154

No. 16-178

16-150	**WEIGHTS,** 1 milligram to 20 grams, in highly-polished mahogany case with cover. Fractional weights, 500 to 10 milligrams of German silver, 5 to 1 milligram of aluminum; with forceps, under stout glass plate	$3.95
16-151	——, same as above, but 1 milligram to 50 grams	4.45
16-152	——, same as above, but 1 milligram to 100 grams	5.75
16-153	——, same as above, but 1 milligram to 200 grams . . . Duty Free	5.40
16-154	——, same as above, but 1 milligram to 500 grams . . . Duty Free	6.90
16-175	**WEIGHTS,** same quality as above, but in highly polished pear-wood block, fractions under a glass cover. One milligram up to 20 grams; with forceps	2.15
16-176	——, same as above, but 1 milligram up to 50 grams	2.95
16-177	——, same as above, but 1 milligram up to 100 grams	3.40
16-178	——, same as above, but 1 milligram up to 200 grams	4.15
16-179	——, same as above, but 1 milligram up to 500 grams	6.85
16-180	——, same as above, but 1 milligram up to 1000 grams	8.75

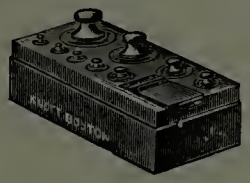
No. 16-227

No. 16-230

16-225	**ALL-IVORY FORCEPS,** 11 centimeters long, best quality	$1.40
16-227	**IVORY-POINTED BRASS FORCEPS,** 11 centimeters long	.75
16-230	**LACQUERED BRASS FORCEPS,** 10 centimeters long	.16
16-250	**FLAT CAMEL'S-HAIR BRUSH,** ½ inch wide, best quality	.16

GENERAL LABORATORY WEIGHTS

Nos. 16–300 to 16–302



Nos. 16–310 to 16–315

No. 16–327

16–300 **BRASS WEIGHTS,** 1 centigram up to 50 grams, in polished hardwood box with cover **$1.85**
16–302 ——, same as above, 1 centigram up to 100 grams **2.30**

NOTE. We recommend these weights in covered boxes, since there is less risk of loss and the weights are kept free from dust.

16–310 **BRASS WEIGHTS,** same quality as above, but in block; 1 centigram up to 20 grams **1.20**
16–312 ——, same as above, 1 centigram up to 50 grams **1.40**
16–315 ——, same as above, 1 centigram up to 100 grams **1.85**
16–325 **BRASS WEIGHTS,** same quality as above, but without fractional weights, 1 gram up to 500 grams **3.95**
16–327 ——, same as above, 1 gram up to 1000 grams **5.60**

NOTE. The use of **No. 16-325** or **16-327** is recommended with Trip Scale **No. 15-160** or **15-165,** as no smaller weight than 1 gram is needed.

Nos. 16–350 to 16–355

16–350 **SEPARATE BRASS WEIGHTS,** as used in "General Laboratory Weights."

	a	b	c	d	e	f	g	h	i	j
Size, grams	1	2	5	10	20	50	100	200	500	1000
Each . . .	$0.07	$0.08	$0.10	$0.12	$0.15	$0.24	$0.36	$0.68	$1.15	$2.25

16–355 **SEPARATE FRACTIONAL WEIGHTS** of German silver, as used in "General Laboratory Weights."

	a	b	c	d	e	f	g	h	i
Size, milligrams . . .	1	2	5	10	20	50	100	200	500
Each	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06

No. 16–370

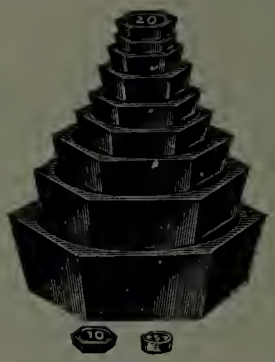
16–360 **FRACTIONAL WEIGHTS,** German silver and aluminum, one each listed under No. **16–355,** with duplicates of the 2, 20 and 200-milligram weights. In cardboard box . . . . . .Per Set **$0.65**

16–370 **FRACTIONAL WEIGHTS,** German silver, as listed under No. **16–360,** but in neat wooden, slide-top box with separate compartment for each size weight **1.24**

16–380 **AVOIRDUPOIS BRASS WEIGHTS,** ⅛ ounce up to 1 pound. In block **4.40**

16–385 **TROY BRASS WEIGHTS,** ½ grain up to 1 ounce. This set is highly recommended for its pedagogic value in teaching the relation of the Troy system and the other systems of weights **1.90**

IRON WEIGHTS



Nos. 16–425 to 16–430

Iron weights are now practically universally used in mechanical powers experiments, with sonometers, etc.

No. 16–440

16–425 OCTAGONAL IRON WEIGHTS, 5 grams up to 1 kilogram . . . . . Per Set **$1.40**
16–430 ——, 5 grams up to 2 kilograms . . . . . Per Set **2.15**

No. 16–450

16–440 DISC IRON WEIGHTS, 1 ounce up to 16 ounces. Set comprises weights of 1, 2, 4 and 8 ounces with duplicate of the 1 ounce . . . . . **.95**

16–450 INTERHOOKING LABORATORY WEIGHTS for general utility in the Physical Laboratory in the study of mechanical advantages of simple machines.

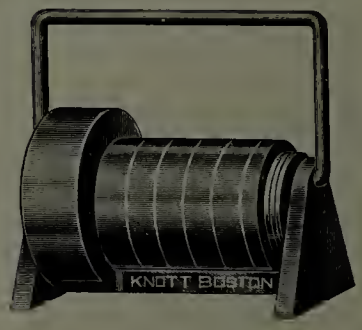
These weights are accurately adjusted from cast hexagonal blocks of iron, of a design permitting the attaching of one weight to the other by a hook, the top of one to the bottom of the other, the hooking attachment in the bottoms, however, not hindering standing each weight upright. The set consists of a 10, 20, 50, 100, 200, 500, and 1000 gram weight, with duplicates of the 20 and the 200-gram pieces. Each weight fits readily into an apartment in a neatly japanned cast-metal holder.

Set complete with holder **2.75**

16–452 INTERHOOKING LABORATORY WEIGHTS. Set complete as above but without holder . . . **2.25**

16–453 CAST METAL HOLDER with separate compartment for each weight listed above **$0.65**

16–460 SLOTTED METRIC WEIGHTS, accurately adjusted. Set of 1-500, 5-100, 1-50, 2-20, and 1-10 gram weights mounted on japanned holder **1.70**



No. 16–460

16–477 SLOTTED METRIC WEIGHTS and WEIGHT HANGER for use in mechanical powers experiments where large capacity weights are not needed. Consists of a nickel-plated brass hanger accurately adjusted to 50 grams weight, and a set of weights same quality and as listed in No. **16–460**—1-500, 5-100, 1-50, 2-20, and 1-10 gram weights.
Set complete with hanger **2.20**

16–478 SLOTTED METRIC WEIGHTS, separate weights same quality as listed above.

	a	b	c	d	e
Size, grams . .	10	20	50	100	500
Each	**$0.18**	**.22**	**.28**	**.35**	**.48**

No. 16–477

16–479 WEIGHT HANGER, accurately adjusted to weigh 50 grams. Nickel-plated. Same as used in No. **16–477** **$0.50**

Nos. 16–485 to 16–500

ADJUSTED METRIC CAST IRON WEIGHTS

These weights are made from carefully-designed patterns, provided with groove and raised ring which enables them to be readily piled on top of one another without danger of slipping and producing confusion in the lecture room or laboratory.

The slot in each is made slightly narrower than the diameter of the hole in the center, enabling the weight to be easily put on and taken off from the Pratt Institute Weight Hanger listed below, and at the same time, preventing the weights from accidentally falling from the hanger. See above cut.

These weights, being made of the finest quality of castings, carefully adjusted, may be depended upon for careful work.

16–485	a	b	c	d
Size, kilos	½	1	2	5
Each	$0.48	.57	.75	1.50

16–487 WEIGHT HANGER, Pratt Institute design.
All of our hangers in this group are made with the upper portion of the rod cut away to fit the slot in the weight, while the main part of the rod is the same size as the hole in the center of the weight. This insures the weights being held securely in position, making it impossible for them to accidentally fall off, and at the same time rendering it easy to put them on and take them from the hanger without removing the hook from its support. This feature adds materially to the ease of their use in the laboratory and is indispensable where large laboratory divisions are a necessity.
Hanger accurately adjusted to weigh 500 grams $0.90

16–489 SLOTTED METRIC WEIGHTS WITH WEIGHT HANGER. Set consists of one each weights listed under No. **16–485** and No. **16–487** Weight Hanger 4.15

UNADJUSTED CAST IRON WEIGHTS

These weights are designed for Mechanical Powers experiments in Applied Physics. While not adjusted to exact weights, being cast uniformly from carefully adjusted patterns, they are sufficiently accurate for all the uses for which they are designed.

As may be noted from the illustration, there are three series. The slots in all the weights are of uniform size. The rods on all the hangers are of the same size, the only difference being in the size of the supporting disc and in the length of the supporting rod.

We recommend Hanger **d** for Weights **a, b** and **c**; Hanger **g** for Weights **e** and **f**, and Hanger **j** for Weights **h** and **i**. (See tabulation below.)

	SERIES 1				SERIES 2			SERIES 3		
	Weights			Hanger	Weights		Hanger	Weights		Hanger
16–500	a	b	c	d	e	f	g	h	i	j
Size, pounds	¼	½	1		2	5		10	20	
Each	$0.11	.14	.18	.45	$0.27	.68	.62	$1.07	1.74	.90

TIME — INDICATORS — SPEED

CLOCKS, PENDULUMS, METRONOMES, ETC.; SPEEDOMETERS

No. 17-10

7–10 LABORATORY CLOCK for general use as an accurate time-keeper and for beating seconds.

This clock has an eight-day, standard movement, weight driven, and we guarantee its reliability as an accurate time-keeper. The lens-shaped bob is of polished brass and the pendulum is full seconds length, the center of oscillation being readily adjusted by means of a thumb-screw. The dial, designed especially for laboratory usage, is not confused by the usual large hour numerals, for since in laboratory practise seconds beats are essential, the seconds divisions are the most prominent. Thus in our dial, the hour and minute divisions with their hands are small, while the seconds divisions are large and the seconds hand is long. All three, however, are sufficient in size to be readily seen from any part of the laboratory.

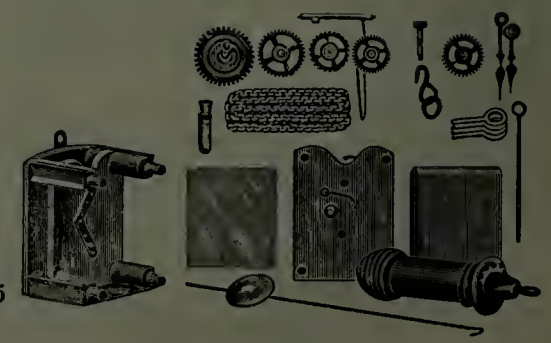
The mercury well is of improved design, exposing a thin strip of mercury adjusted by means of an easily accessible knurled thumb-screw. The graduated arc affords an excellent, simple device for leveling, when setting up the clock in the laboratory.

The case of our clock is of polished mahogany, designed practically dust-proof. It is, in appearance, equal to the excellent quality of the movements which it contains. It is provided with binding posts for electrical connections for attaching battery and sounder **$54.00**

17–15 MAGNETIC CLOCK CONTACT for attachment to any laboratory clock, making an adjustable positive contact that cannot get out of order.

The design of a magnetic clock contact was first suggested to avoid the disagreeable features accompanying a mercury contact. The contact is positive and the make-and-break instantaneous. It is readily attached to any seconds pendulum, or any make laboratory clock with swinging pendulum. Complete, ready for attachment **12.00**

17–25 INTERVAL TIMER. This is a well-made, handsomely nickel-plated and reliable interval timer especially valuable in all experiments in which action for a definite length of time is necessary. The alarm may be set to ring at the expiration of any interval from one-quarter of a minute up to two hours. Complete with directions **2.45**

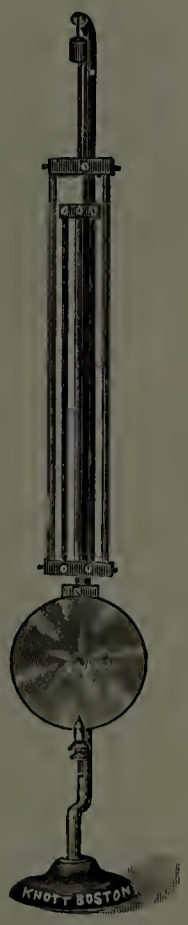


No. 17–40

17–40 DISSECTED CLOCK, for student's use in the study of weight-driven clocks. All parts are mounted on card numbered or lettered for easy reference. All parts are substantially built and accurately fitted and no tools are necessary in assembling. Being of simple construction, no mechanical skill is needed to assemble, — directions furnished with each clock being full and simple. Assembled, the clock will keep good time.

This clock is highly recommended for its educational value in making clear the complexity of parts of an expensive time-keeper. It has the further value of increasing the interest of the student. Complete, with full directions, in a neat box **$2.45**

No. 17-50



No. 17-60

No. 17-75

17-50 FULL-SWEEP SECONDS PENDULUM for beating seconds in laboratories where the more expensive laboratory clock is not available.

This pendulum consists of a full-sweep seconds pendulum with metal bob, cast lens-shape to overcome air resistance, and suspended on ground and polished steel edges in a special stirrup. It is mounted on polished hardwood board with an adjustable mercury well designed to expose a thin strip of mercury sufficient to cause a positive contact. The mercury is adjusted by means of a screw. Further adjustment is possible by the adjustable contact tip. Binding posts are conveniently placed for connection of battery and sounder . . . . . $ 5.90

17-55 FLASH SECONDS PENDULUM, after Turner and Hersey (Exp. S010) 1.30

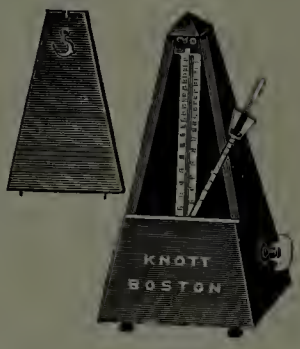
17-60 ZINC AND IRON COMPENSATING PENDULUM, illustrating employment of metals having different coefficients of expansion in keeping the distance between the center of suspension and the center of oscillation constant. Consists of alternate rods of zinc and iron, so attached that the expansion of one is compensated by the expansion of the other. Mounted on neatly finished base . 12.35

17-75 COMPENSATING MERCURY PENDULUM, an accurately constructed, handsomely finished, full-length seconds pendulum, compensated by the expansion of mercury.

This design, a modification of the Graham's mercury pendulum, consists of a steel rod as in a simple seconds pendulum, but in place of the disc bob are suspended two glass mercury wells in suitable holders. All adjustments are provided. Simply operated and effectively working. The apparatus is handsomely finished throughout and the quality of workmanship is of the finest.

Complete as illustrated, with stirrup, but without mercury 6.75

No. 17–90



No. 17–120

No. 17–150

No. 17–165

17–90 CLOCK DEMONSTRATION BALANCE WHEEL, — two compound bars, electrically welded and mounted in connection with a spring, substantial base, pivot bearing, as indicated in the accompanying illustration, showing clearly the principle of the self-regulating balance wheel in watch and clock movements **$4.25**

17–120 METRONOME for time-marking in laboratory experiments in the study of Falling Body, Pendulum, etc. This instrument has a graduated scale and a marker operated by spring-driven clockwork enclosed in polished mahogany case **3.50**

17–125 METRONOME WITH BELL. This is the same quality Metronome as above, but has the additional feature of a bell attachment which can be regulated to sound every beat, every second, third or fourth beat as desired **5.35**

17–150 STOP WATCH, an indispensable accessory to the equipment of any well-equipped laboratory. This watch is of excellent quality, stem wound, lever movement, beating one-fifth seconds, neatly polished nickel case with stop **7.10**

17–165 STOP CLOCK, with 5-inch dial and with seconds hand. In highly-polished mahogany case. Designed to be hung on the wall or placed on a table. This clock is an accurate time keeper, having the distinctive feature of being an inexpensive stop clock with qualities that would warrant its adoption in class-room demonstrations **9.80**

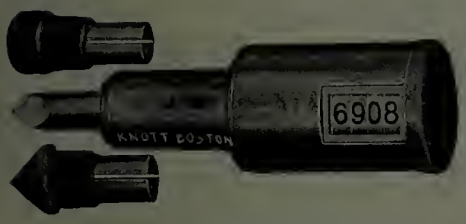
No. 17–200

17–200 UNIVERSAL SUN DIAL. In our Sun Dial, which may be adapted to any latitude, we offer an instrument scientific in design and capable of accurate work. It is 12 inches square, substantially constructed of metal and can be continuously exposed in any climate without injury. By an ingenious arrangement, not illustrated, a correct setting for any latitude can easily be obtained. We supply with each instrument a printed form on which a correction curve for any locality can readily be plotted from full and explicit directions furnished with each instrument.

Each instrument is durably finished with a protective coating, the figures and lines showing in colors against the black finish on the casting.

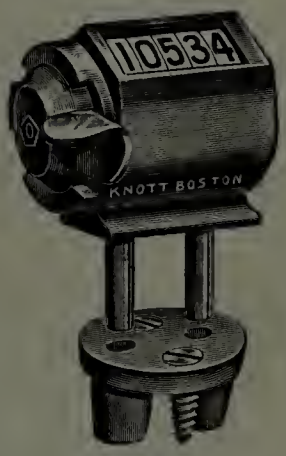
Universal Sun Dial, complete with directions for correct setting for any latitude **7.50**

No. 17–300



No. 17–305

No. 17–310



No. 17–325

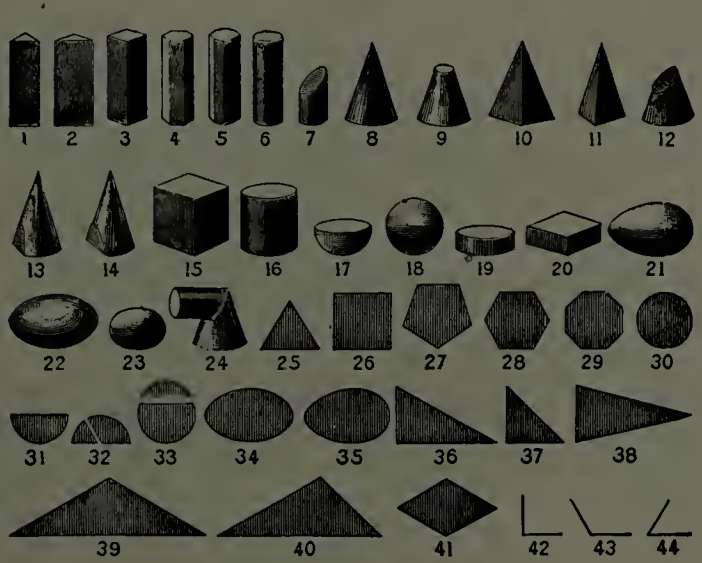
17–300 IMPROVED SPEED COUNTER for measuring speed of rotation of shafts in efficiency experiments, etc. The indicating dial is graduated into one hundred parts and graduations show every revolution and with two rows of figures which read both right and left **$1.10**

17–305 SELF-REGISTERING SPEED COUNTER. Registers up to 9,999 revolutions on low or high speeds up to 5000 R. P. M. Registers in either direction. When shaft turns one way the counter adds, the other way it subtracts. Complete with one pointed and one flat insulating tip **3.40**

17–310 SELF-REGISTERING SPEED COUNTER. Registers in either direction up to 99,999 revolutions . **1.50**

17–325 SELF-REGISTERING HAND COUNTER. Operated by slight hand pressure upon small lever shown in illustration. Complete with socket plate **2.00**

MATHEMATICAL MODELS



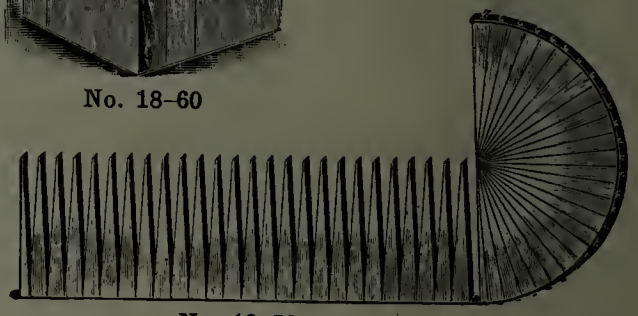
No. 18–10

18–10 GEOMETRICAL WOODEN FORMS, consisting of twenty-four solids, seventeen surfaces, and three angles, the latter being represented by bent wires. Solids are accurately turned from well-seasoned hard wood, surfaces cut with accurate steel dies from stiff, hard, light-colored board. Complete in strong wooden box, with table of contents pasted on the under side of the cover . . . **$2.95**

No. 18–20

No. 18–30

No. 18–60



No. 18–50

18–20 CONE, SPHERE, and CYLINDER for ocular demonstration of the relation between the contents of cone, sphere, and cylinder. The cone and cylinder are 3 inches deep by 3 inches in diameter. Actual demonstration shows that the cone, three times filled with water, fills the cylinder, and that the cylinder filled with water and sphere submerged, enough water will remain in the cylinder to fill the cone, thus showing that their contents are as the ratio **1: 2: 3** . . . . . Per Set **$1.10**

18–30 DISSECTIBLE CONE for illustrating conic sections, circle, ellipse, parabola, and hyperbola. This cone is made of different kinds of hard wood, highly polished on the surface, each section held by large pins. Being of ample proportions, sections are of convenient demonstrating sizes **3.35**

18–40 TRIANGLE DEMONSTRATION APPARATUS for demonstrating mechanically that the area of a triangle is equal to its base multiplied by one-half its altitude.
The apparatus consists of two triangles so hinged that by simply swinging certain parts on their hinges, the triangles resolve themselves into two rectangles 12 inches long by 3 inches high . . . **1.45**

18–50 CIRCLE AREA DEMONSTRATION APPARATUS for demonstrating mechanically that the area of a circle is equal to the radius multiplied by one-half the circumference. The apparatus consists of a large number of sectors attached at their bases by a pliable band connecting them by hinges. This band is in two parts, so that the circle made of sectors may be separated into two semi-circles. When these two semi-circles are straightened out, two toothed forms result. By inserting the teeth of one form between the teeth of the other a rectangle is formed. The base of this rectangle, then, is a semi-circumference and its height, the radius of the circle. The diameter of disc is 8 inches . **2.10**

18–52 BRASS DISC, 8 centimeters diameter .with radius indicated, after Millikan, Gale and Bishop (Exp. 1) . . . . . **.27**

18–55 HOLLOW BRASS CYLINDER, with glass cover, after Millikan, Gale and Bishop (Exp. 2) . . . . **.65**

18–60 CUBE ROOT BLOCKS for illustrating in a simple manner the underlying principles of cube root extraction. The apparatus consists of an accurately dissectible wooden cube, the size of the inner cube being 3 inches on an edge and the assembled cube being 4 inches **2.00**

MODELS OF CRYSTALS

No. 18–125

18–125 CRYSTAL MODELS OF SOLID GLASS, a set consisting of six models, representing the six basic geometrical forms. In neat cardboard case **$4.75**

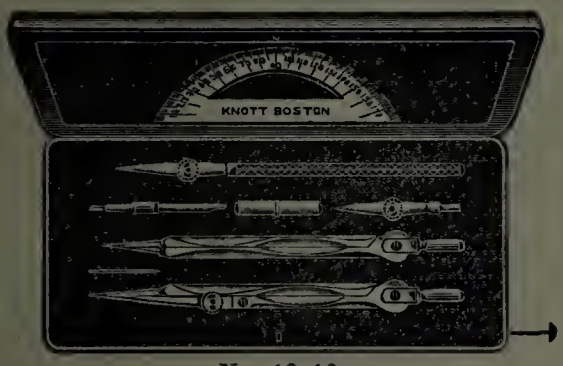
18–130 CRYSTAL MODELS OF SOLID GLASS, a set of twenty different forms, surfaces ground and polished, axes 3 to 6 centimeters in length. Enclosed in case . . . . . Duty Free **8.00**

18–200 CRYSTAL MODELS OF WOOD, consisting of thirteen different forms, representing the most common crystal formations. In cardboard box **2.60**

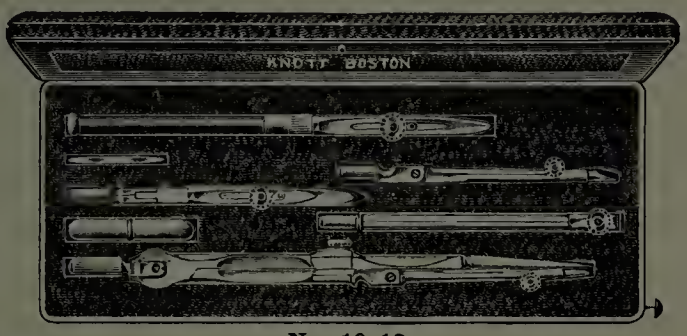
DRAWING INSTRUMENTS

In listing our line of drawing instruments, we have in mind the elementary requirements of such a class of goods, yet we believe that fewer instruments, rather than cheaper grade, are advisable if the school's appropriations will not warrant the expenditure for such instruments.

The line of instruments which we list are made of hard-pressed German Silver, and finished steel. They have received all the improvements of fine tools and will be found capable of very exact work.



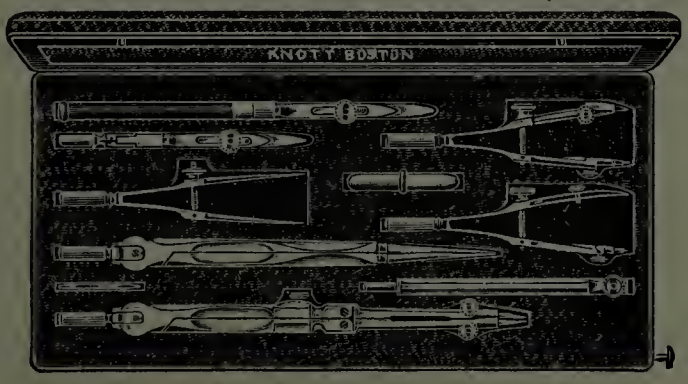
No. 19–10



No. 19–12

19–10 **DRAWING INSTRUMENTS,** good quality hard-pressed German silver and polished steel, containing the following instruments, in a neat leather case, lined with velvet:
Ruling pen, 5 inches, with patented spring back lever.
Compass, 5½ inches, with fixed needle point, pen, and pencil point.
Plain dividers, 5½ inches.
Metal protractor, 3½ inches.
Box of leads. Complete set **$1.50**

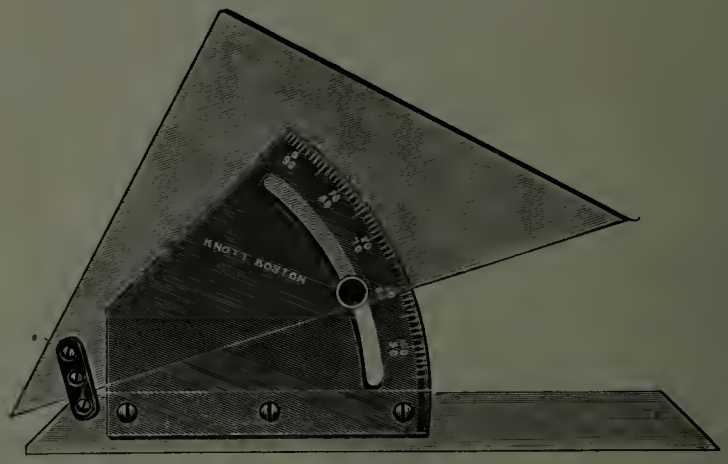
19–12 **DRAWING INSTRUMENTS,** extra quality hard-pressed German silver and polished steel. Set containing the following instruments in a neat morocco pocket case lined with velvet:
Ruling pen, 5½ inches, with patented spring back lever.
Compass, 6 inches, with fixed needle point, pen, pencil point, and lengthening bar.
Steel divider point.
Box of leads. Complete set **2.65**



No. 19–14

19–14 **DRAWING INSTRUMENTS,** extra quality hard-pressed German silver and polished steel. Set containing the following instruments, in morocco pocket case lined with silk velvet:
Ruling pen, 5 inches, with patented spring steel back.
Plain divider, 6 inches.
Compass, 6 inches, with fixed needle point, pen, pencil point and lengthening bar.
Steel spring bow pencil, 3½ inches.
Steel spring bow pen, 3½ inches.
Steel spring bow divider, 3½ inches.
Box of leads. Complete set **4.80**

No. 19–23



No. 19–34

19–20 **SCHOOL COMPASS,** as illustrated in set No. **19–10,** with fixed needle point and pencil point . . . **$1.15**

19–23 **UNIVERSAL PENCIL COMPASS** for student's use in diagram work in laboratory. These pencil compasses are inexpensive, yet strong and serviceable. Capable of drawing circles up to 12 inches in diameter.
Complete as illustrated, with pencil . . . . . Per Dozen **1.50**

19–25 **STEEL SPRING BOW DIVIDER,** 3½ inches, as included in set No. **19–14** . . . . . **.72**

19–30 **PARALLEL RULE,** best quality, made of clear ebony with brass mountings. Length 12 inches . . **1.00**

19–32 **T-SQUARE,** cherry wood, 24 inches long, with fixed cross head . . . . . **.40**

19–34 **AMBRO UNIVERSAL SET SQUARE.** This square, imported by us, has many features which can only be realized by use. Designed to secure the same utility as a number of instruments, it has advantages over each, in that it can be instantly adjusted to perform their various duties. It is an accurate protractor, graduated to read from 0 to 90 degrees in two directions; it is an accurate try square; it is a right angle triangle; it is a straight edge, etc., etc.
It is substantially constructed and its accuracy is unexcelled. Its universal adaptation to uses of many instruments at a cost far below that of these instruments is a feature to which we desire to call particular attention **1.75**

19–40 **PEARWOOD TRIANGLE,** framed, extra quality, 30 degrees. Size 10 inches . . . . . **.26**

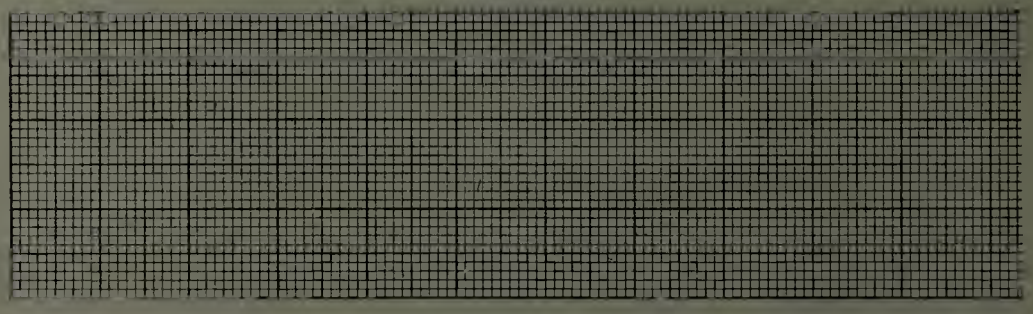
19–41 ——, same as above, but 45 degrees. Size 8 inches . . . . . **.28**

19–42 **TRANSPARENT AMBRO TRIANGLE,** 30 and 60 degrees. Size 10 inches . . . . . **.77**

19–43 ——, same as above, but 45 degrees. Size 8 inches . . . . . **.77**

19–50 **DRAWING BOARDS** of clear grained pine wood, having two drawing surfaces, with side ledges.

	a	b	c
Size	16 × 22	20 × 24½	23 × 31 inches.
Each	**$1.05**	**$1.60**	**$2.15**

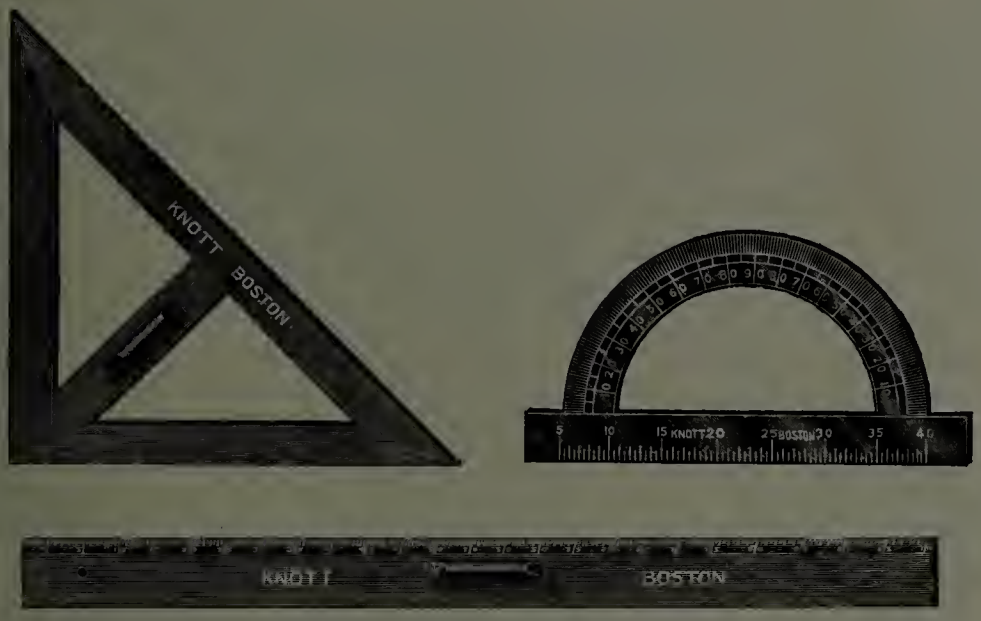


Nos. 19–67 to 19–68

19–65 **CROSS-SECTION PAPER.** 1/10 inch divisions, printed on heavy bond paper 17 × 22 inches. Sheet **$0.06.** Doz. **$0.68**

19–67 **CROSS-SECTION PAPER.** One millimeter divisions with heavy centimeter rulings 15 × 20 centimeters, on heavy bond paper 8½ × 10½ inches. This is our National Physics Note-Book Cross-Section Sheet with holes punched for use in our Binders . . . . . Per 100 Sheets **.60**

19–68 **CROSS-SECTION PAPER,** same ruling as No. **19–67,** but printed on drawing paper 22 × 27 centimeters . . . . . Per 100 Sheets **1.80**



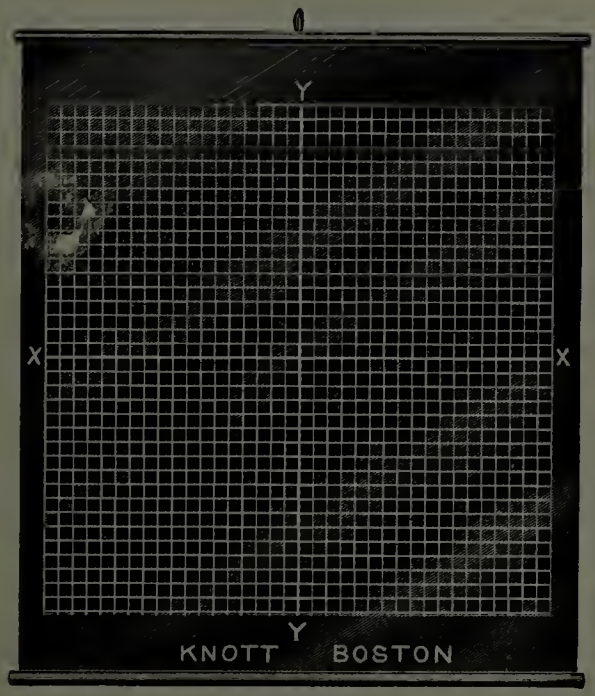
No. 19–75

19–70 BLACKBOARD DIVIDER AND COMPASS. Superior quality, substantially constructed and handsomely finished.
Length 16 inches **$0.60**

19–75 EXTRA LARGE BLACKBOARD DRAWING INSTRUMENTS. Essential where accurately constructed diagrams are required of either teacher or pupil.
These instruments, imported by us, must not be confused with the ordinary quality on the market. The set offered under this number is accurately and substantially constructed, each being provided with conveniently situated handle. The set is made from the best close-grained, well-seasoned wood, polished and oil finished. The ruler is a full meter, graduated the full length into clear, distinct, black filled divisions. The triangle, 50 centimeters long, has angles of 45 and 90 degrees. The protractor, 40 centimeters in diameter, has two scales, the linear and angular, the latter reading in two directions, divisions and figures filled black . . . . . Set of Three **6.25**

19–77 ——, similar to above but ordinary grade **4.50**

19–100 GRAPH CHART, graph 36 × 36 inches, lithographed on blackboard canvas 3 × 4 feet, mounted on plain roller. Each square measures exactly one inch. The center lines are extra heavy and are accurately squared.
This chart simplifies the reading of co-ordinates and other mathematical principles, plotting of geometrical figures, projection of planes, curves, etc., for showing progress of experiments in Physics, and is practically indispensable for graphic representation of temperature, rainfall and humidity in Physical Geography. It may be considered a necessity in high school work **$3.25**



No. 19–100

MECHANICS

PROPERTIES OF MATTER

No. 20–10

No. 20–20

No. 20–25

20–10 POROSITY DEMONSTRATION APPARATUS for illustrating the porosity of wood. Apparatus consists of an oak wood funnel, a conveniently sized bell glass and glass dish as illustrated.
In use, the apparatus is placed grouped as illustrated on the plate of an air pump. Mercury is placed in the wood funnel. After a few strokes of the lever, the mercury will begin to run through the pores of the wood into the glass. Complete as illustrated **$1.70**

20–11 WOOD FUNNEL, as used in above . . . . . **.85**

20–12 BELL GLASS, as used in above . . . . . **.85**

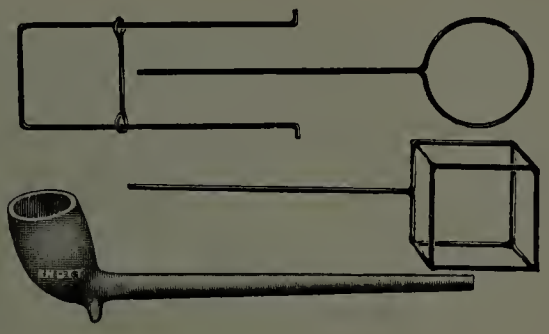
20–13 GLASS DISH, as used in above . . . . . **.10**

20–20 VISCOSITY APPARATUS for determining the viscosity coefficient of a liquid. Apparatus consists of a capillary tube with bulb so that the time of outflow is at least 100 seconds. The liquid flows under its own pressure to the capillary. An accurately known quantity is introduced into the wider tube and then sucked up the other tube until the liquid has risen above the bulb. The time occupied by the liquid flowing from this height to a point below the bulb is noted and coefficient determined **1.60**

20–25 JENKINS' SPECIFIC GRAVITY APPARATUS. This apparatus employs, in principle, the effusion test of Bunsen which is based on the fact that the specific gravities of two gases are inversely proportional to the squares of the speeds with which they escape through a minute opening. It is used by the Gas Inspectors of Massachusetts and New York for specific gravity determinations and will be found sufficiently accurate for all practical purposes. It will be found fully as accurate as the Schilling's Specific Gravity Apparatus so frequently found in use, and the cost is considerably less.
The advantages of the Jenkins' Specific Gravity Apparatus are, — its portability, its low cost, its rapidity and accuracy.
Complete directions furnished with each outfit sold. Price, complete with stand **12.50**

No. 20–90

No. 20–95



No. 20–100

20–90 **LEAD COHESION DISCS** for illustrating molecular cohesion between metals. Apparatus consists of two hemispheres of lead with faces carefully ground smooth.
When the two surfaces are pressed tightly together, the cohesion between the lead molecules offers a resistance to separation $0.38

20–95 **GLASS COHESION DISCS** for illustrating molecular cohesion between two glass plates. Apparatus consists of two all-glass hemispheres with carefully ground faces.
When the two faces are pressed tightly together, the cohesion between the glass molecules offers a resistance to separation 55

20–100 **FILM DEMONSTRATION APPARATUS** for illustrating characteristics of films demonstrating Surface Tension and Cohesion.
The apparatus consists of three wire frames of different forms with pipe for blowing spherical films. Striking results are possible from proper use of these frames. Tendency of all films to attain a circular form is quite noticeable . . . . . .Per Set as Illustrated .90

No. 20–110

No. 20–115

No. 20–117

20–110 **PRINCE RUPERT DROPS** for illustrating the stress existing between the inside and outside of a glass when it is allowed to cool suddenly. These drops consist of drops of glass which had their surfaces cooled suddenly so that they became rigid, before the inner surface had had time to cool. There is considerable stress, therefore, between the outside and the inside, but the stress being distributed over the surface, a state of equilibrium exists which is only disturbed when a small portion is broken, when the drop will explode into very small pieces. In use, therefore, the drop should be covered with a piece of paper so that when the small tail is broken off no one will be exposed to the flying fragments . . . . . .Per Dozen $0.25

20–115 **BOLOGNA PHIALS.** These phials are made in a similar manner to the Prince Rupert Drops and illustrate the stress existing by allowing small pieces of flint to move about inside the flask, thus causing small scratches which result in the bottom flying to pieces. This is a spectacular experiment, as only a very slight scratch will cause the bottom to fly out . . . . . Per Ten 1.50

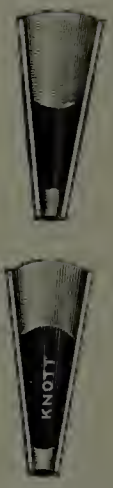
20–117 **ADHESION DISC** for illustrating adhesion between glass and a liquid. Apparatus consists of a circular glass plate, 3 inches in diameter, having at its center a polished wood cone at the apex of which is fastened a fine thread for attachment to a balance arm when experimenting . . .Each .30

20–120 **FRICTION OF WATER APPARATUS** for showing the increase of friction caused by a film of water between metal surfaces. (Hall No. XXVII) 2.25

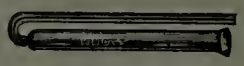
No. 20–125

20–125 **GLASS PLATES FOR ILLUSTRATING CAPILLARITY.** Consists of 2 plates of glass, which may be placed in a shallow dish of water at any desired angle, when a curve will result somewhat as illustrated . . . . . Per Pair **$0.25**

20–126 **GLASS PLATE SEPARATOR** for holding 2 glass plates, as No. **20–125,** at any desired angle in a dish of water. Consists of a small wedge with detents for holding to tops of the plates . . . . . **.50**

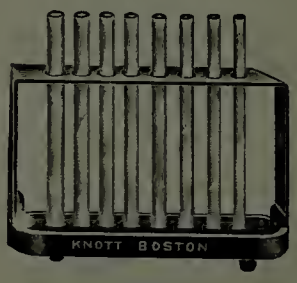


No. 20–130

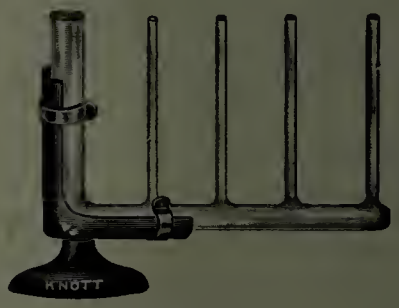


No. 20–155

Nos. 20–134 and 20–135



No. 20–140



No. 20–150

20–130 **TAPERING CAPILLARY TUBES** for demonstrating capillarity in tubes. Consists of a tapering glass tube 4 inches long.
This is a very excellent, inexpensive piece of apparatus for demonstrating capillarity in tubes of different diameters **$0.35**

20–132 **CAPILLARY TUBES,** set of 4 tubes of different internal diameters, 4 inches in length . . . Per Set **.30**

20–134 **CAPILLARY TUBES ON SUPPORT,** consisting of a set of four tubes of different diameters, mounted on support, for placing over top of a small jar . . . . . **.40**

20–135 **SMALL JAR,** for use with No. **20–134** Capillary Tubes . . . . . **.10**

20–137 **CAPILLARY TUBES,** set of eight tubes of different internal diameters for illustrating capillarity Per Set **.45**

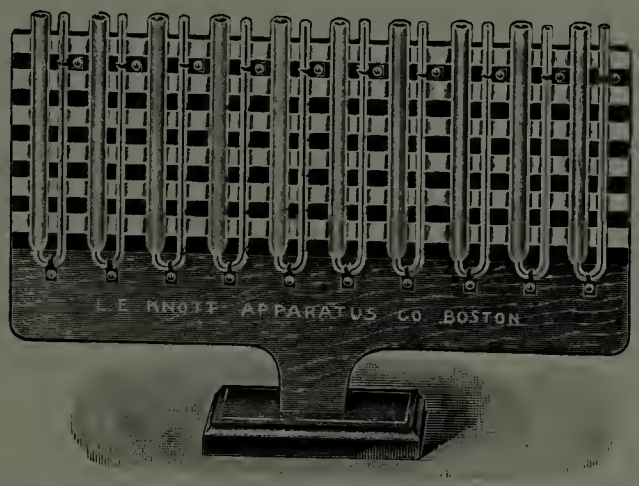
20–140 **CAPILLARY TUBES AND STAND,** consisting of eight tubes of different internal diameters mounted in a stand.
The stand illustrated is a valuable adjunct in the study of capillarity, in that it allows of view of a number of tubes at the same time, also affording convenient means for lantern projection. Finished in japan and gun-metal finish. Stand complete with eight tubes of different internal diameters **1.15**

20–145 **CAPILLARY TUBES,** consisting of four capillary tubes of different internal diameters connected to a water reservoir. For illustration see No. **20–150** . . . . . **.75**

20–150 **CAPILLARY TUBES AND SUPPORT,** consisting of No. **20–145** Capillary Tubes, mounted on a neat cast-iron base. Base is provided with lacquered brass clips for holding glass part in place. Stand is handsomely finished in japan **1.22**

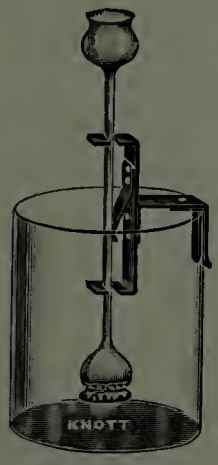
20–155 **CAPILLARY U–TUBE,** consisting of glass U-tube, one branch of which is a small capillary tube with white backing . . . . . **.33**

20–160 CAPILLARY TUBES ON STAND, consisting of ten U-tubes, one branch of each being capillary, and all of different internal diameters, mounted on support with scales for noting relative rise of liquid in the tubes **$6.15**



No. 20–160

No. 20–200



No. 20–215

No. 20–220

20–200 ENDOSMOMETER for illustrating the phenomena of Endosmose and Osmose.

The apparatus consists of a glass vessel the lower end of which is covered by a membrane, the upper end of which is connected to a glass tube which carries a scale. This vessel is supported so that the membrane is held under solution during examination.

All parts complete as illustrated **$3.70**

20–215 STUDENTS' OSMOSIS APPARATUS for qualitative as well as quantitative work in Osmosis.

The apparatus consists of an osmosis tube of design as illustrated, held adjustably in a nickel-plated clamp which may be clamped to the side of a jar. One end of the osmosis tube is closed by a thin porous membrane which may be removed and replaced from time to time as needed.

Apparatus complete as illustrated **1.25**

20–220 OSMOSIS APPARATUS after specifications by Thos. B. Freas of the Department of Chemistry, Columbia University, for illustrating the phenomenon of Osmotic Pressure.

This ingenious device consists of an S. & S. diffusion shell attached to a glass chamber which ends above in a heavy wall barometer tube 5 feet long. Entering this chamber is another tube with a funnel end and stop-cock through which the solution is allowed to flow.

For ease and rapidity of illustration this apparatus is unexcelled and the results are readily noticeable within fifteen minutes from the start.

Osmosis Tube with diffusion shell only, without support of any kind **$3.90**

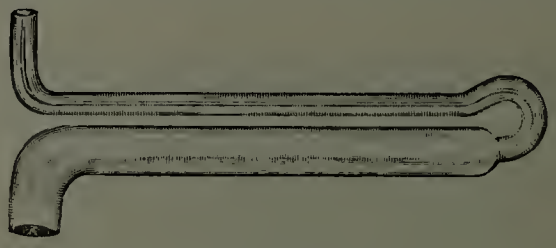
Articles illustrated in addition are:

22–130 UNIVERSAL STAND **2.10**

5–850 UNIVERSAL RIGHT-ANGLE CLAMP **1.05**

31–265c BATTERY JAR, 6 × 8 inches . . . . . **.40**

20–222 DIFFUSION SHELL, as used in above apparatus . . . . . Each **$0.40,** Per Ten **4.00**



No. 20–230

No. 20–235

20–230 SCHIFF'S SURFACE TENSION APPARATUS for the study of surface tension in liquids.
Consists of a special U-tube, one limb of which has large bore, the other capillary bore, bent at the top at right angles and with an enlargement just at the bend to prevent stoppage of the mouth of the tube by deposited drops $1.10

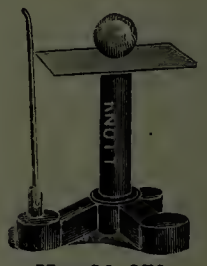
20–235 HALL'S SURFACE TENSION APPARATUS, designed by Dr. E. H. Hall of Harvard University for quantitative measurement of surface tension. This apparatus will be found most effective for determining the surface tension of any liquid not acting on metal. Complete with stand as illustrated 3.60

20–235A ——, as illustrated, but without Stand $2.95

20–236 SHALLOW FLINT GLASS DISH for above 15

No. 20–250

No. 20–260



No. 20–270

20–250 INCOMPRESSIBILITY OF LIQUIDS APPARATUS, IMPROVED DESIGN, for the quantitative observation of the incompressibility of liquids.
This apparatus consists of a tube with indicating capillary. The liquid to be observed should fill the short arm of the tube and should rise in the long arm to near the top of the capillary. If mercury is poured into the long arm, the liquid, if compressible, will indicate the amount, if any, in the capillary.

Complete as illustrated, mounted on our No. **41–116** Boyle's Law Stand . $4.25

20–251 INCOMPRESSIBILITY OF LIQUIDS TUBE, only 2.50

20–260 IMPENETRABILITY APPARATUS, illustrating the fact that two bodies cannot occupy the same space at the same time.
This apparatus consists of a frame which answers the double purpose of supporting the bottle and plunger and of a clamp. In use, the bottle is filled with the liquid, a one-hole rubber stopper placed in the neck, the end of the plunger placed in the hole and the bottle clamped firmly in place by means of the thumb nuts. If the plunger is now thrust into the bottle, the bottle will burst, demonstrating that two objects cannot occupy the same space at the same time, also, that a liquid is incompressible.
Complete, with three bottles 1.45

20–270 INERTIA APPARATUS for illustrative demonstration of Inertia.
The apparatus consists of a neatly finished base on which is mounted a nickel-plated rod with concave top. A metal spring fastened to the side of the base affords a device for giving the card illustrated a sudden blow on the edge, thus knocking the card from under the small ball, showing that the ball does not change its position except as gravity causes it to drop into concave top when its prop is knocked from under.
Complete as illustrated 85

CENTRIFUGAL FORCE

ROTATORS

No. 21-175

No. 21-160

No. 21-10

21-10 ZIEGLER TWENTY-ONE POUND MECHANICAL ROTATOR OR WHIRLING TABLE with universal chuck for rotating objects to which it is desired to apply a centrifugal force.

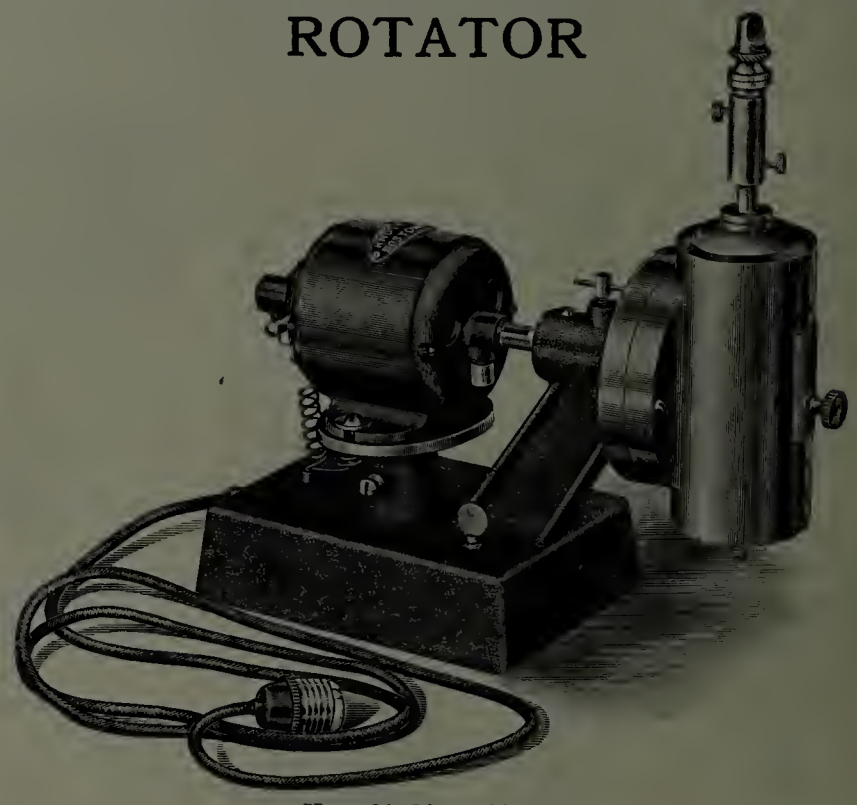
In the design of our Rotator we have observed closely all the scientific requirements of such an instrument. It is made of cast iron, all parts neatly japanned, and may be used in either a vertical or horizontal position. In design of our patterns we have placed the metal at points where the greatest stability may be secured. Furnished with each rotator are the various attachments for fastening the accessories. Thus there will be found with each instrument a universal chuck for fastening objects with a spindle; also a special lock-nut head designed for fastening plates, color discs, etc., and for attaching the string of such accessories as the Disc, Egg, and Chain.

Important features of this instrument are,—

1. Extreme rigidity, used in either vertical or horizontal position.
2. Large Drive Wheel, facilitating either high or low speed.
3. Handsome and durable finish.

Rotator only, without accessories, also illustrated, but including the universal chuck attachment **$6.95**

THE UNIVERSAL SPEED AND POWER ROTATOR



Nos. 21–30 to 21–35
Patent Pending

The motor rotator is desirable, if not essential, in Physical Laboratory demonstration, but the important problem of adequate power at low speed has not before been solved, two hundred revolutions being considered the low limit at which reasonable working power may be obtained.

We have, by the friction drive method, produced a **Universal Speed** and **Power Rotator** which runs without unnecessary friction and in which the power is **increased** as the speed is **diminished,** a feature which gives to it a breadth of usefulness not ordinarily looked for in these instruments.

While primarily designed for all of the usual whirling table experiments, it serves admirably as the power plant in **prony break tests** and in the **Mechanical Equivalent of Heat experiments** where the greatest smoothness as well as low speed and great power are required. When operated at high speed the outfit is particularly well adapted to the **energizing of gyroscopes** of high power.

FEATURES

UNIVERSAL POSITION. The countershaft housing, being designed so as to rotate through a complete circle, gives any desired position to the chuck holder.

A SPEED CONTROL which has never before been obtained in a rotator, from 0 to 5000 revolutions.

A METHOD OF REVERSING which is as simple as it is unique, carrying the shaft from the highest speed on one side gradually down to 0 and gradually up to the desired points on the other side, all without jar or shock, it being accomplished without touching a switch or reversing key.

POWER. Full power of the motor when the countershaft is running at the same speed as the motor and which **increases** in the same **ratio** as the **speed diminishes,** giving almost **unlimited torque** at very **low speed.** The crowning of the drive disc so as to insure greater contact pressure as the power is increased.

SAFETY. All parts enclosed so as to eliminate all danger from any moving portions of the instrument.

SPEED COUNTER. A direct connected speed counter attached to the countershaft, giving actual number of revolutions of the effective shaft. The counter may be thrown in or out of mesh at will.

UNIVERSAL CHUCK SOCKET. A chuck socket which readily takes all of the whirling table attachments, requiring no wrench for adjustment.

WEIGHT. The base of the instrument, a solid casting, supported by shock-absorbing points, stands firm and rigid on the lecture table, requiring no clamping.

VOLTAGE OF CURRENT

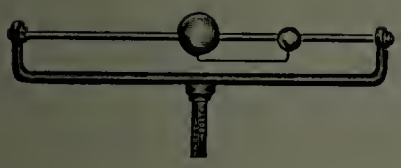
In ordering, specify the current for which the motor is desired: — 110 volts D. C. or 110 volts, 60 cycles A. C. See listing below.

21–30 Rotator complete with Universal Chuck, for 110 volts D. C. **$42.00**
21–35 Rotator complete with Universal Chuck, for 110 volts A. C. **42.00**

21–45 **SPECIAL DRIVE PULLEY** for round belt. This drive pulley will be found essential when using above rotators as the driving mechanism for Mechanical Equivalent of Heat Apparatus (see page 230) or other apparatus. It is designed with set screw to attach to shaft of either of above rotators **$1.75**

ROTATOR ACCESSORIES

No. 21–50



No. 21–100

No. 21–60

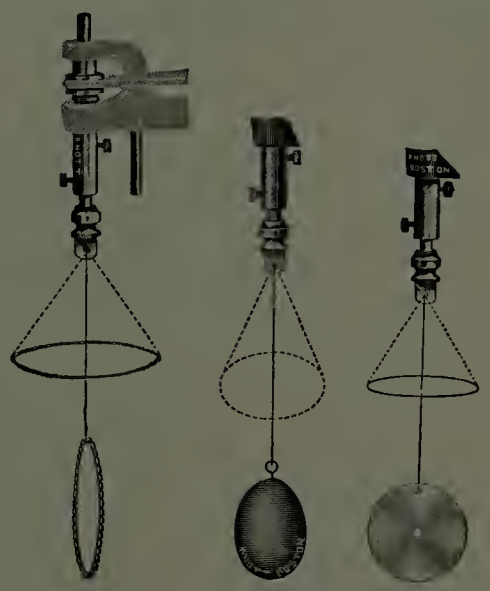
No. 21–80

21–50 SPEED INDICATOR for attachment to the Whirling Table when quantitative results are desired. This indicator is a high-grade instrument especially adapted to use on our Rotator. Illustration shows method of attachment to the Rotator **$4.15**

21–60 SPRING STEEL DOUBLE CENTRIFUGAL HOOP for illustrating the tendency of a semi-fluid body, such as the Earth, to assume a flattening at the poles when rotating rapidly.
The apparatus consists of two flexible hoops of spring steel mounted on a central axis for attaching to the spindle of the Rotator **1.65**

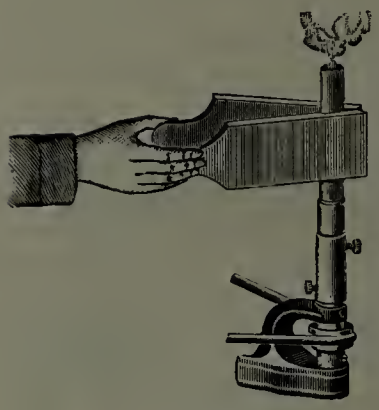
21–80 FOUCAULT'S PENDULUM for illustrating conservation of the plane of oscillation.
This design consists of a carefully finished wooden disc with quadrants clearly marked, the under side of which is provided with an accurately centered spindle for attachment to rotator. The uprights support a pendulum, the point of suspension being directly over center of the disc.
In use, the pendulum is allowed to swing in the plane of the apparatus and then set slowly in rotation. The pendulum will maintain the course of its plane of vibration **$6.50**

21–100 CENTRIFUGAL FORCE APPARATUS, consisting of two connected balls of unequal mass mounted on a horizontal rod attached to a frame for connection to the Rotator **1.90**



No. 21-110

21–110 CHAIN, EGG and **DISC** for illustrating the tendency of a body to rotate about its shortest diameter.
Consists of a Disc, a Chain and an Egg-shaped solid, each with an attached cord for suspending to the head of the Rotator **$0.88**



No. 21–120

No. 21–150

No. 21–175

21–120 TYNDALL'S INSULATED HEAT BY FRICTION ATTACHMENT for illustrating heat caused by friction on a brass tube while rotating rapidly.

Apparatus consists of a cylinder of brass carefully insulated from the brass rod with which it is connected to the rotator. If this cylinder is filled with alcohol and friction caused during rotation by means of the Friction Vise, it will be noted that the liquid is soon boiling.

Complete as described **$2.00**

21–150 CENTRIFUGAL SEPARATOR for separating by centrifugal force solids held in suspension in a liquid.

The apparatus consists of a spindle with cross head. To the forked end of this cross head, brass collars are held in cone bearings. In these collars are placed the centrifuge tubes with their aluminum shields.

When rotated rapidly, solids held in suspension in a liquid contained in the tubes will gather at the bottom **2.46**

21–152 CENTRIFUGAL TUBE, after Hall (No. **XLI**) Figure **102** to illustrate centrifugal action . . . . . **.58**

21–160 CENTRIFUGAL DRYER for illustrating the principle of centrifugal devices as used in laundries. For illustration see page 77 . . . . . **3.90**

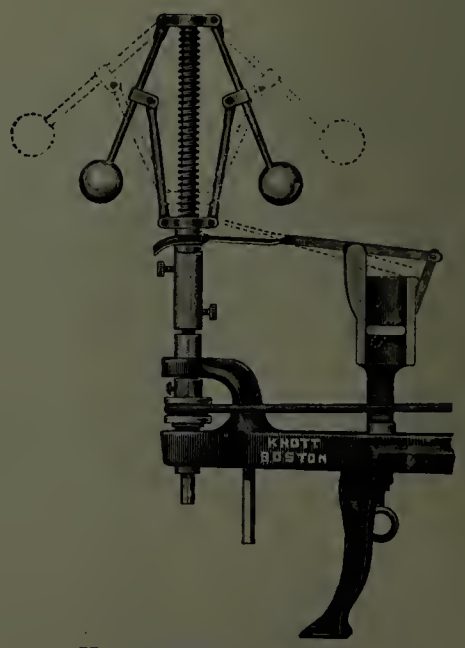
21–175 TWO-IN-ONE GLASS ROTATOR GLOBE for showing effect of rotation upon solids or liquids of unequal weight. This apparatus takes the place of both the glass globe for liquids and the open shallow dish for solids, both of which are required for complete demonstrations.

If three balls of same size but unequal weight, or if two or more liquids of different specific gravities but which do not mix (mercury and water) are placed within the globe and the globe rotated, interesting and instructive phenomena will be noted. This globe is of heavy glass and carefully balanced to rotate evenly **$2.85**

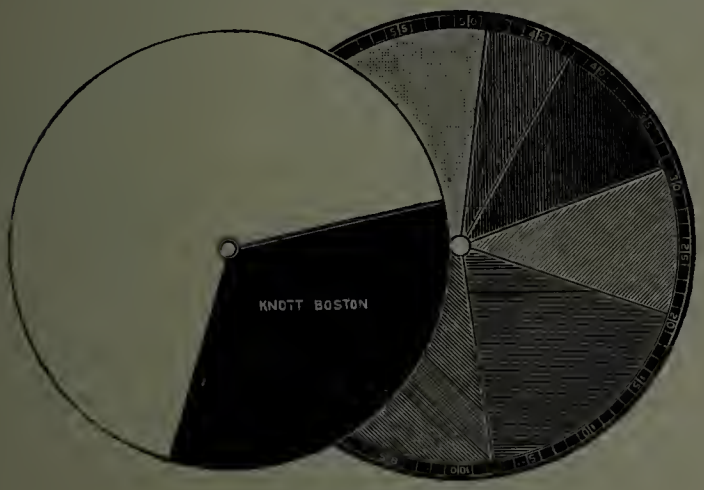
21–185 WATT'S GOVERNOR for demonstrating the usefulness of a governor on an engine.

The apparatus consists of two metal balls suspended to two arms which in normal position hang downward, but pivoted so that in rotation they are free to rise and act against a spring. Made of brass throughout and finished in lacquer and nickel **3.95**

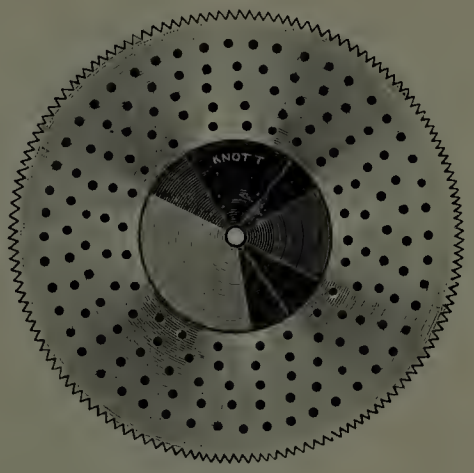
21–190 VALVE REGULATOR, to be used in conjunction with above Watt's Governor in demonstrating the action of a governor in regulating the flow of steam into the steam chest of an engine. Finished in bright japan with different parts colored for distinction at a distance from the lecture table **3.40**



Nos. 21–185 and 21–190



No. 21–210



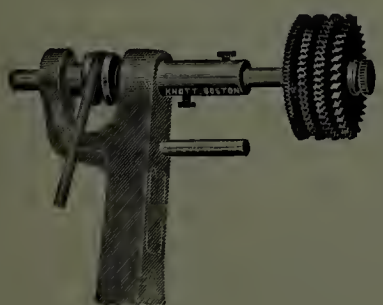
No. 21–225

21–210 LARGE LECTURE TABLE COLOR DISCS for quantitative work in color mixing and color analysis. These discs are of heavy cardboard with hole for attaching to spindle of Rotator. Each disc is slit that two or more colors may be combined, giving a disc of several colors.

Set of discs of seven primary colors, one each of black and white, and a percentage circular protractor for quantitative work **$2.00**

21–225 COMBINATION NEWTON'S COLOR DISC, SIREN DISC and **SAVART'S WHEEL** for showing white light when fixed portions of primary colors are rotated rapidly, and for demonstrating propagation of sound by mechanical disturbances which cause vibration in the surrounding media.

Consists of a flat disc of metal with part of the face covered with colored segments of the seven primary colors in best proportions to show white when disc is rotated rapidly. Outside this colored portion there are drilled five rows of holes on concentric circles, four of which are evenly spaced and sound the tones C, E, G, and C′, while the fifth is unevenly spaced and sounds a harsh tone, — a noise. On the periphery of the disc are cut evenly spaced teeth . . . . . Each . **1.50**



No. 21–240

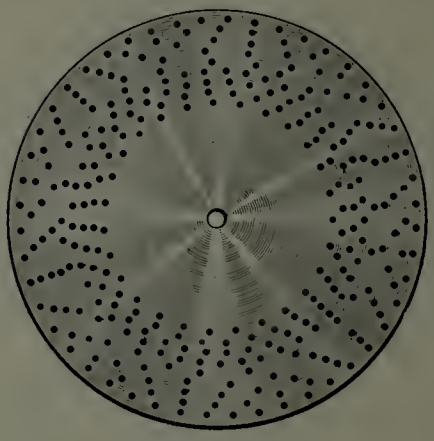
No. 21–245

21–240 SAVART'S TOOTHED WHEEL for demonstrating that tones are produced by regular impulses given to the surrounding media.

Consists of four brass discs on the periphery of which are cut teeth, which, when touched by a card during rotation, will sound the tones of C, E, G, and C′. These discs are held fixed to a spindle for attaching to the socket of the Rotator. Finished in nickel throughout **$2.35**

21–242 ——, similar to above, but with only one wheel. For attachment to socket of the Rotator . . . **.48**

21–245 SAVART'S TOOTHED WHEEL, mounted on stand for string rotation. Consists of a heavy metal casting with teeth equally spaced on the periphery. This disc is mounted on axle and supported on a heavy casting. Durable japan and black oxidized finish **7.65**



No. 21-257

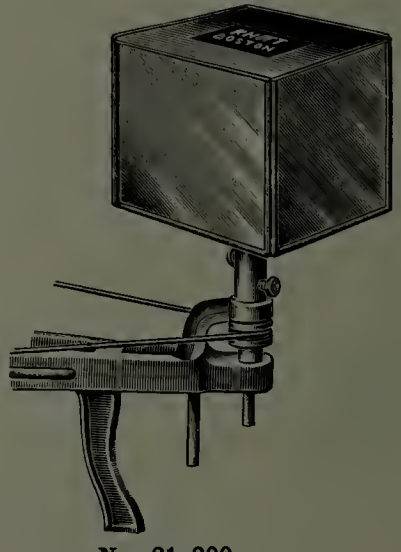
21-255 **SIREN DISC,** illustrating sound propagation by regular impulses given to the surrounding medium.
Consists of a flat metal plate with five rows of holes in concentric circles, four of which rows have holes equally spaced to sound the tones C, E, G, and C′, while the fifth is unequally spaced to sound a "noise."
Disc is emery finished and nickel-plated **$1.05**

21-257 ——, same as above, but with nine rows of holes in concentric circles, eight of which are equally spaced to sound the scale of C, D, E, F, G, A, B, and C′, while the ninth is unequally spaced to sound a "noise." **2.75**

No. 21-267

21-267 **AIR IMPULSE ATTACHMENT** for use with Siren Discs Nos. **21-225, 21-255,** and **21-257** for sounding by air impulses against the holes, one or more notes up to nine.
This instrument is an ingenious device provided with nine air valves, any or all of which may be opened by small thumb screws. It may be instantly adjusted to our Rotator. It is handsomely finished, positive in action and cannot get out of order. Operated by blowing or by air bellows, requiring only a moderate blast. Attachment only **$2.65**

No. 21-280



No. 21-290

No. 21-295

21-280 **CROVA'S DISC AND METAL SHIELD** for attaching to Rotator to illustrate compressional waves.
The apparatus consists of two parts, — a heavy cardboard disc 11 inches in diameter, on the face of which are drawn progressively eccentric circles, and a flat metal shield 12 inches in diameter with special clamp for attaching to a rotator. A slot cut along a radius of the shield exposes a narrow strip of the card showing short sections of the eccentric circles. When the card is rotated these short sections show alternate expansion and compression. Complete **$2.45**

21-280a **FLAT METAL SHIELD with ATTACHED CLAMP** **2.25**

21-280b **CROVA'S DISC,** heavy cardboard, 11 inches diameter . . . . . **.20**

21-290 **CUBICAL OR ROTATING MIRROR,** for attachment to Rotator for study of reflection from a Rotating Mirror or for Manometric Flame images.
This design consists of four mirrors, one fastened firmly to each of the four vertical sides of a cubical box, to the under side of which is attached an accurately centered spindle for fastening to socket of rotator. All parts finished dead black **3.15**

21-295 **KOENIG'S MANOMETRIC FLAME CAPSULE** for transmitting the motion of sound waves to gas flame, which by their pulsations indicate the nature of sound.
This design consists of two metal castings, between which is sealed a membrane. One casting is provided with jet, other with mouth-piece and connecting tubing. The whole is mounted on a gas tube attached to a substantial metal base.
Complete as illustrated **2.75**

No. 21–300

Patent Pending

No. 21–300 (Sectional View)

21–300 REVOLVING MIRROR, WITH POSITIVE SPEED GOVERNOR. To meet the repeated demands for a mirror which may be revolved at varying speed and of a size sufficiently large for ordinary laboratory work we have, after considerable experimentation, devised the above illustrated method.

This mirror is self-contained in that the power is contained in the base in the form of a battery motor, with "start" and "stop" key. We secure a positive speed, governed by means of a simple, effectively operating device noted above the mirror shaft. We are able to secure with this device speeds varying from a few revolutions per minute up to 4000, the maximum speed of the motor. This variation in speed may be made during the revolution of the mirror simply by a movement of the milled screw over the axle.

As may be noted this design consists of a metal housing which serves also as a substantial base. Cast to this housing is an upright with projecting arm. The mirror is mounted in metal castings carefully centered. The metal housing is provided with binding posts for connections to the motor and also with "start" and "stop" key. The whole is finished in nickel and black oxidized, presenting a handsome appearance. It will be found efficient for all general work for which a rotating mirror is used $9.75

No. 21–305

No. 21–310

21–305 ARAGO'S MAGNETIC ROTATION APPARATUS, for demonstrating the reaction between the electric currents induced in a rotating copper disc and a magnet, illustrating, also, the damping effect of copper upon a magnetic needle.

The apparatus consists of a metal casting which may be attached to our rotator as illustrated, and which carries adjustable arms for supporting a clear glass plate with beveled edges. Fastened at the center of this glass plate is a small support for the Magnetic Needle. The apparatus is finished in lacquered brass and bright japan.

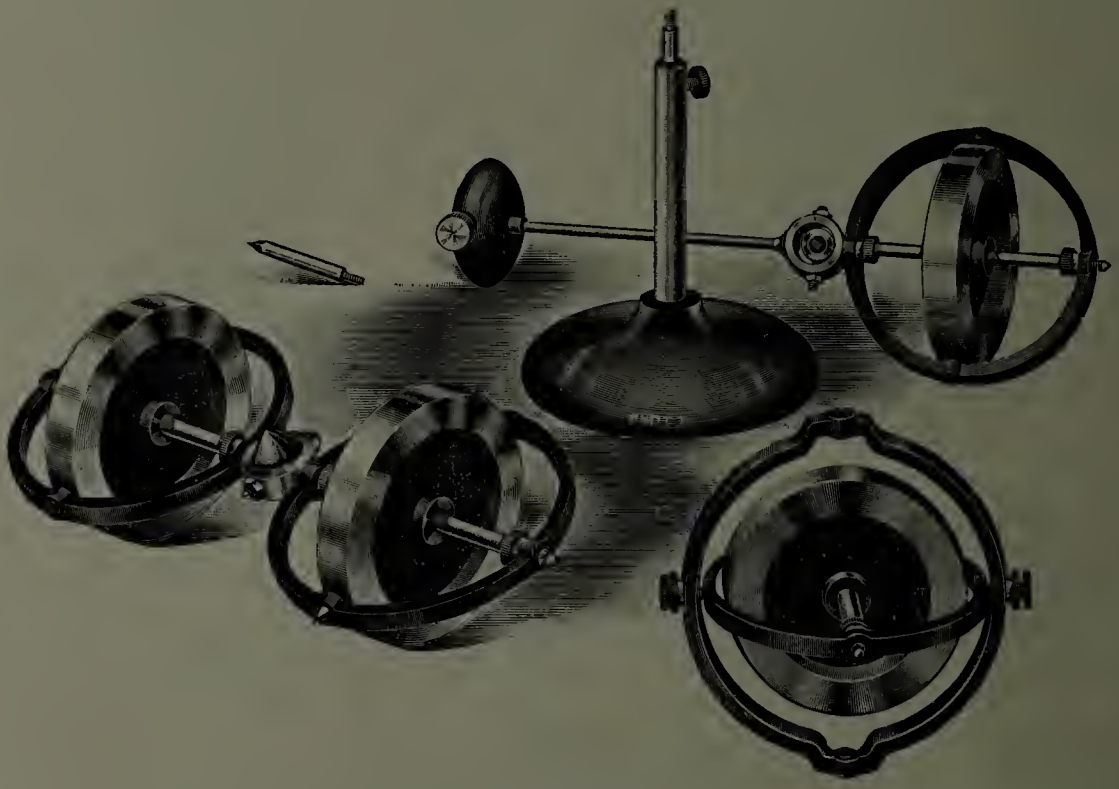
As the copper disc is rotated, the Magnetic Needle is deflected in the direction of the rotation, and if the speed is fairly great, the needle will be dragged completely around so that it is set in rotation. When the rotation is stopped the damping effect of the copper is strikingly noticed.

Apparatus complete as illustrated, ready for attachment to our rotator $5.85

21–310 EARTH INDUCTION APPARATUS, for mounting to the socket of a rotator to illustrate induced currents set up in a coil of wire by the inductive action of the earth.

This apparatus consists of a closed coil of wire wound on metallic frame, provided with commutator and brushes, ready for attachment to a rotator 6.85

THE HARCOURT UNIVERSAL GYROSCOPE



No. 21-340
Patent Pending

It is with much satisfaction that we list here this valuable series of instruments for demonstrating gyroscopic phenomena.

The plan on which these instruments are designed is that of using the simple unit to demonstrate the simpler forms of gyroscopic action and to build up from this unit a complete line of accurate and well-worked-out gyroscopes.

If it is not possible to purchase the complete outfit at once, the simple element with stand may be purchased at first, and other features added at will until the complete system is obtained. By this plan, a full set of gyroscopes may be obtained at much less cost than the separate instruments.

THE BASIC UNIT. This consists of a perfectly balanced wheel 3½ inches in diameter, so designed that the mass is kept as near the periphery as possible.

DETAILED FEATURES

LOCK-NUT on Basic Unit. The method of holding the wheel in its gimbal ring is unique, in that the lock-nut is so placed that it serves to prevent the power string from catching in the bearing when in use.

UNIVERSAL BEARING POST. A convenient and well-designed reversible bearing post is fitted to the base standard. It serves the multiple purpose of providing a suitable pivotal bearing, a thread post for attaching any of the rings, and a cup support for the ball-bearing on the end of the main axle.

UNIVERSAL GIMBAL BEARING. A valuable adaptation of the gimbal bearing worked out by E. S. Ritchie to give the greatest freedom of motion with the least friction. The use of this bearing is well illustrated in the building up of both the **COUNTERPOISED** and the **BOHNENBERGER** types of instruments.

The various parts going to make up the complete outfit may be briefly stated as follows·

1 **STAND, UNIVERSAL ROD** with Cone and Cup Bearings.
2 **ROTATING WHEEL SYSTEMS (BASIC UNITS).**
1 **EXTENSION ROD WITH COUNTERPOISE.**
1 **EXTENSION ROD STILT ATTACHMENT.**
1 **GIMBAL RING AND BEARING.**
1 **BOHNENBERGER RING AND BEARING.**

It will thus be seen that from the basic unit, by the addition of accessory parts, we are able to assemble all forms illustrated below. For example:—

In order to assemble the **SIMPLE GYROSCOPE** No. **21–360,** use the Supporting Stand with Universal Cone and Cup Bearing and the Basic Unit.

To assemble the **COUNTERPOISE GYROSCOPE,** No. **21–355,** the only additional parts would be the Extension Rod and Counterpoise, together with the Gimbal Bearing, if desired.

To assemble the **BOHNENBERGER GYROSCOPE,** No. **21–350,** only the Bohnenberger Ring need be provided in addition to the above.

The **COMPOUND GYROSCOPE,** No. **21–345,** requires one extra Basic Unit.

The Extension Rod Stilt Attachment supplied with each outfit enables one to set up the **STILT GYROSCOPE** (not listed or illustrated below) for illustrating the resistance exerted by a spinning gyroscope in the monorail to wind pressure, causing the whole carriage to lean over toward the wind and to lean more and to increase its resistance in exactly the same ratio as the force of wind increases.

It will thus be seen that the cost of the Gyroscopic Outfit in this form will be much less than the cost of the individual instruments furnished complete. This is our reason for strongly advising the purchase of one complete outfit, if possible.

21–340 GYROSCOPIC OUTFIT complete as listed **$17.45**

NOTE. — Great care is exercised in testing out all of the parts with their interchangeable features before the instruments are shipped.

No. 21–345

No. 21–350

No. 21–355

21–345 FESSEL'S COMPOUND GYROSCOPE. This Gyroscope consists of two of the Basic Units described on the preceding page, mounted on stand as illustrated. We desire to call attention to the fact that with the purchase of this Compound Gyroscope, simple gyroscopic action as illustrated under No. **21–360** may be demonstrated by dissembling the Compound Gyroscope and using the parts as illustrated **$11.00**

21–350 BOHNENBERGER'S GYROSCOPE. This Gyroscope, as may be readily noted, consists of our Basic Unit with the addition of the Bohnenberger Ring and Bearing. It will be noted, also, that this Gyroscope may be dissembled and used in demonstrating simple gyroscopic phenomena as illustrated under No. **21–360** **8.75**

21–355 COUNTERPOISE GYROSCOPE, assembled as illustrated from the Simple Gyroscope Basic Unit, Extension Rod and Counterpoise, Gimbal Ring and Bearing, and mounted on a Stand with Universal Bearing Post **7.50**

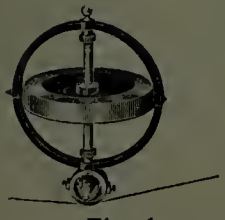


Fig. 1

No. 21–360

Fig. 2

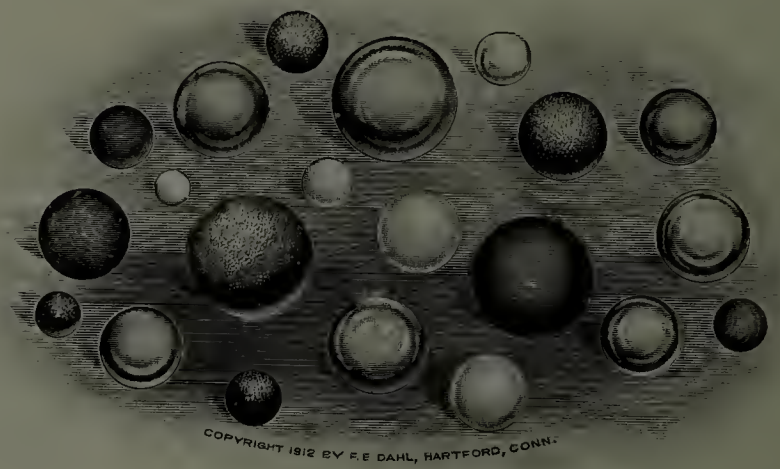
21–360 SIMPLE GYROSCOPE, 3½ inch wheel. This instrument is not a toy, although the illustrations depict its use in positions as so frequently advertised by toy manufacturers. Under this number, we supply the Simple Gyroscope Basic Unit with Supporting Stand and Universal Bearing Post. Perhaps no single instrument is capable of such spectacular results as that of the Simple Gyroscope, and every school equipment should have at least one, constructed scientifically and sufficiently massive to place it in the realm of scientific instruments **$5.50**

21–367 SIMPLE GYROSCOPE, light wheel, usual form **1.90**

21–371 "SPINNING TOPS" by Professor Perry, who, in a very simple and interesting manner, describes and explains many interesting experiments . . . . . Per copy **1.25**

ACTION AND REACTION

BALLS



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Nos. 22–10 to 22–110

PENDULUM BALLS, for use also in Action and Reaction Experiments.

22–10 WOODEN BALLS:

	a	b	c	d
Diameter, inches	¾	1	1½	2
Price	$0.05	$0.10	$0.12	$0.16

22–20 GLASS BALLS:

	a	b	c
Diameter, inches	¾	1	1½
Price	$0.05	$0.15	$0.35

22–30 IVORY BALLS, accurately turned, polished, and with a hole drilled for suspension:

	a	b	c
Diameter, inches	1	1½	2
Price	$1.60	$1.90	$2.50

22–40 LEAD BALLS, made of cast metal, drilled for suspension:

	a	b	c	d
Diameter, inches	⅝	¾	1	1½
Price	$0.05	$0.09	$0.16	$0.54

22–50 BRASS BALLS, accurately turned, polished, drilled for suspension:

	a	b	c	d
Diameter, inches	½	¾	1	1½
Price	$0.12	$0.17	$0.30	$0.78

22–60 IRON BALLS, cast, a, b, and c drilled for suspension; d and e with hooks.

	a	b	c	d	e
Diameter, inches	¾	1	1½	2	3
Price	$0.06	$0.07	$0.13	$0.20	$0.50

22–61 MASSIVE IRON BALL WITH THREE HOOKS **$0.70**

22–70 HIGHEST GRADE STEEL BALLS, hardened, accurately ground and polished. There are no holes, but the small balls may be suspended by shellacing a thread to them.

	a	b	c	d	e	f
Diameter, inches	⅜	½	¾	1	1½	2
Price	$0.04	$0.06	$0.09	$0.20	$0.40	$1.10

22–72 STEEL BALLS, with loop attachment for suspension, 1 inch diameter **$0.50**

22–80 FINISHED LIGNUM-VITAE BALLS, 1½ inches in diameter . . . . . **.30**

22–90 COPPER BALLS, not turned but drilled for suspension:

	a	b	c
Diameter, inches	¾	1	1½
Price	$0.22	$0.33	$0.67

22–100 CORK BALLS, lathe turned, and drilled for suspension:

	a	b	c
Diameter, inches	¾	1	1½
Price	$0.06	$0.10	$0.20

22–110 COMBINATION SET OF BALLS, for use in collision experiments, giving a variety of weights with approximately the same size. The set consists of 1½ inch balls of cork, ivory, lignum-vitae, glass, iron, brass, copper and lead . . . . . Set **$4.20**

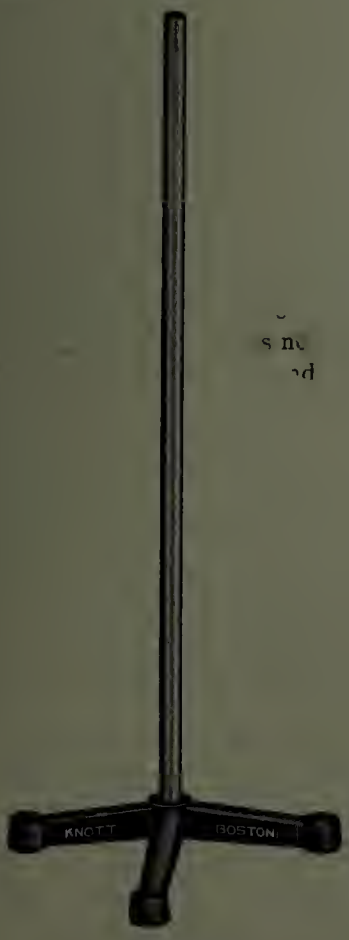
ACTION AND REACTION

IMPACT SECOND LAW OF MOTION

In this place, we desire to call attention to the fact that we have, wherever practical, discarded wood supports, using in all our designs special castings made from expensive patterns. This line, therefore, will be found practically indestructible. It is scientific in appearance and any laboratory may well be proud of a thorough equipment. Each casting is uniformly smooth and appropriately finished. Wherever a clamp is a part of the casting, the screw is heavily nickel-plated.

22–130 UNIVERSAL STAND. It will be noted from this point on, that frequent use is made of a Support Rod mounted in a Tripod Base. We desire to call attention to the extreme utility of this stand. Besides forming a rigid support for various accessories illustrative of the Laws of Mechanics under discussion, it presents a handsome appearance and will support practically all of our accessories illustrated in the following pages. It consists of our No. **5–20e** Support Rod, 100 centimeters long, 19 millimeters diameter, and our No. **5–155** Tripod Base.

We list it herewith as a unit, that we may emphasize its extreme utility. Complete as illustrated . **$2.10**



No. 22–130

22–131 UNIVERSAL STAND, same as above, but tripod provided with three leveling screws **$3.15**

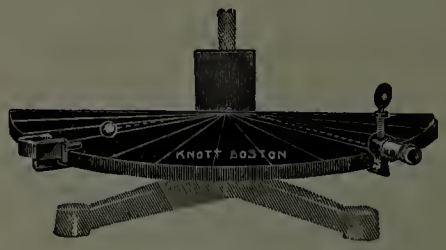
22–135 IMPACT APPARATUS, illustrating by impact of equal masses the resolution of one force into two equal forces.

The apparatus consists of a casting with clamp for attaching to our Universal Support No. **22–130.** This casting is provided with friction taper plugs for holding the balls of equal masses in bi-filar suspensions. At rest, the lengths of these suspensions should be adjusted so that the balls just touch each other.

By impact of one ball simultaneously against the other two, it will be noted that each of the impinged balls is forced a distance equal to half that which the impinging ball traversed.

Complete as illustrated, ready for attachment to rod of Universal Stand **$3.25**

No. 22–135



No. 22–145

22–145 IMPACT AND REFLECTION ATTACHMENT for determining the laws of impact, also for determining law of incidence and reflection of light.

This attachment consists of a special clamp casting to which is firmly fastened the graduated half-circle disc of wood. As a part of this casting, is an impact plate and "boss." To the latter are swiveled two arms, one of which is equipped with a spring gun, designed to project a ball against the impact plate, the other with stop for receiving ball after rebound from impact plate.

By setting the arm carrying the spring gun at some position and projecting the ball against the plate, it will be found that the stop will have to be moved to a similar position on the other side of the normal line.

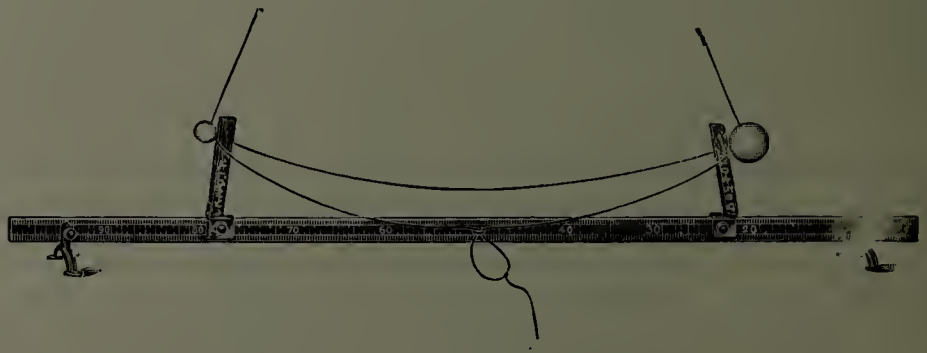
A simple attachment making this apparatus of greater utility is provided on the spring gun arm. This consists of an upright with sight hole. If a lighted candle is placed in the stop, which is designed for this double purpose, and a mirror attached to the impact plate, it will be found that the sight hole will have to be moved to a similar position on the other side of the normal to receive the reflection of the candle.

Attachment complete as illustrated, with the addition of a Mirror for determining the law of incidence and reflection of light **$6.65**

NOTE. ACCESSORY APPARATUS NEEDED

22–130 UNIVERSAL SUPPORT **$2.10**

CANDLES. See Index.



No. 22–160

22–160 ACTION AND REACTION APPARATUS for quantitative demonstration that Action is equal but opposite to Reaction when two elastic bodies impinge.

The apparatus consists of a mounted Meter Stick on which are placed and clamped, where desired, two ingenious detents. Two ivory balls suspended from any convenient hanger rest against these detents and are released by a sudden pull on a string which drops the detents, thus allowing the balls to fall towards each other, starting at the same instant.

Complete apparatus as listed separately below **$5.50**

22–160a METER STICK, with loop for string . . . . . **.33**

22–160b METAL SUPPORTS for Meter Stick . . . . . Per Pair **.25**

22–160c DETENTS ready for attachment to Meter Stick . . . . . Per Pair **.60**

22–160d IVORY BALLS, two of different masses . . . . . Per Pair **4.40**

No. 22–180

No. 22–190

COLLISION BALL APPARATUS, IMPROVED FORM, for the quantitative and qualitative study of impinging elastic bodies.

The apparatus consists of a rectangular metal frame of special design for attachment to our Universal Stand No. **22–131.** Ten steel balls, 1 inch in diameter and one steel ball four times the mass of each of the others are attached to this frame by stout silk cords and held adjustably to it by tapering plugs. As each ball is held in a bi-filar suspension, the directive force of impact is at the will of the operator simply by turning the tapering plugs. A special design graduated arc is necessary for quantitative work. This arc is made to attach directly to the Universal Stand No. **22–131.** The lines and figures being especially clear, they may be seen from the rear of any lecture room.

22–180 **COLLISION BALL APPARATUS,** complete with No. **22–131** Universal Stand, Rectangular Attachment with ten steel balls, 1 inch in diameter, and one steel ball of four times the mass of each of the others, and with Graduated Arc with Clamp for attachment to the Universal Stand . . **$14.75**

22–181 **RECTANGULAR FRAME** with **CLAMP,** including all balls, listed above **9.85**

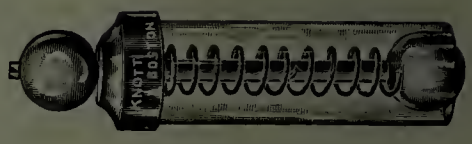
22–182 **GRADUATED ARC** with **CLAMP** as used in No. **22–180** **2.60**

22–131 **UNIVERSAL STAND** **3.15**

22–190 **COLLISION BALL APPARATUS** for study of impinging elastic bodies.
This apparatus consists of a rectangular frame similar in general construction to that used above but designed for suspending five lignum-vitæ balls, each in bi-filar suspension. The apparatus illustrated is designed to clamp over any 19 millimeter rod.
Rectangular Frame with the five balls attached **3.85**

No. 22–200

No. 22–220



No. 22–225

22–200 MOMENTUM APPARATUS for deriving laws of momentum.

This apparatus is designed for attachment to our Universal Support No. **22–131.** It consists of a rectangular metal frame supporting in bi-filar suspension two bodies with masses of the ratio 1: 4. The larger body has a special ingenious spring striking attachment operative on both bodies at the same time. In operation, this striking attachment is pulled back against the spring and held by a piece of string. When this string is burned a blow is given to the smaller body which is communicated to the larger at the same time.

The complete apparatus consists of the Rectangular Frame Momentum Attachment, the Universal Support No. **22–131** and a Graduated Arc. Complete apparatus **$11.00**

22–201 MOMENTUM ATTACHMENT only **5.65**

22–182 GRADUATED ARC WITH CLAMP for attachment to a 19 millimeter rod **2.60**

22–220 SECOND LAW OF MOTION APPARATUS consisting of a flexible hardwood strip about 15 inches long and a vise for attaching one end firmly. The hardwood strip has a right angle head with a notch at each upper end in which are placed small marbles.

In use, the marbles are placed in position in their respective notches; the flexible strip is then bent to one side and released. One marble will shoot out horizontally, while the other, owing to its inertia, will drop automatically, at the same instant taking the course of a straight line, thus demonstrating the Second Law of Motion.

Complete with Vise **1.45**

22–221 BENCH VISE CLAMP as used in No. **22–220** **1.00**

22–222 FLEXIBLE HARDWOOD STRIP as used in No. **22–220** . . . . . **.45**

22–225 SECOND LAW OF MOTION APPARATUS. This design, above illustrated, is one simplified for use in the hand. The length of the rod is such that when rod and attached ball are pulled against the spring and then allowed to be propelled from the tube, the second ball will drop from the rod at the same instant as the ball and rod leave the tube, both reaching the floor at the same instant, although one drops in a plumb line and the other describes a parabolic path **2.90**

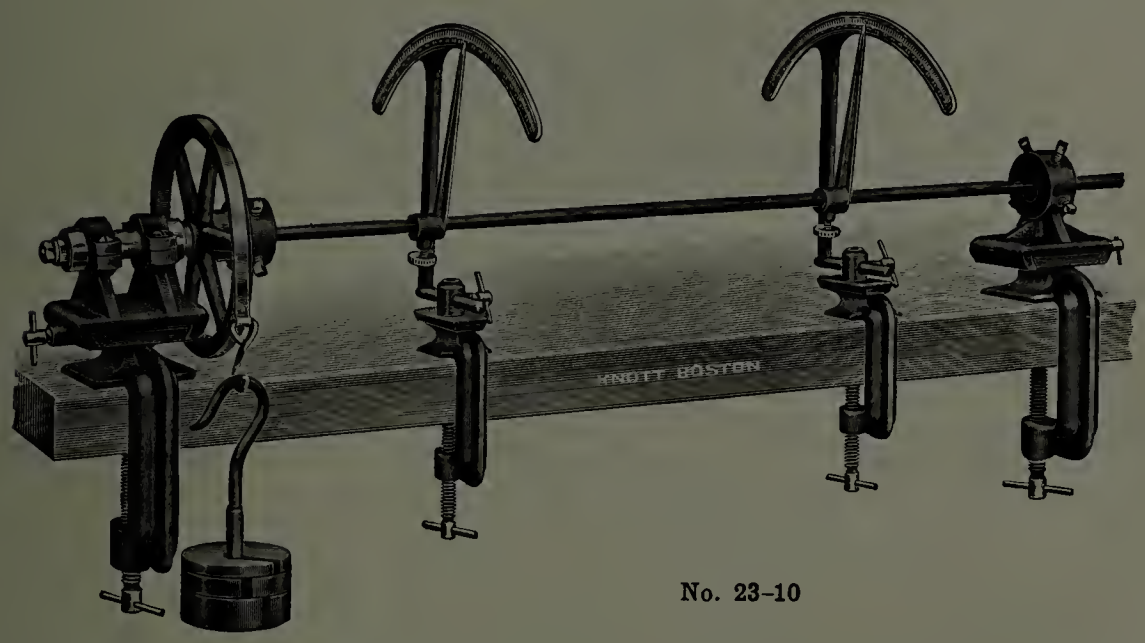
22–230 GAGE'S SECOND LAW OF MOTION APPARATUS.

This apparatus consists of a metal casting holding a rod actuated by a spring. Two spheres are provided, one solid while the other is drilled for slipping over one end of the rod when the spring is held back for releasement. The solid sphere is placed in position as illustrated, so that when the spring is released the end of the rod will inflict a blow upon it, shooting it out in a horizontal position. The rod is of such length that when the spring is released the drilled ball will drop at the same time as the solid ball receives its blow. It will be observed that the solid ball describes a parabola while the drilled ball drops in a plumb line, both reaching the floor at the same instant.

In use this apparatus should be firmly attached to a heavy wooden block or to a table top **2.75**

STRESS AND STRAIN

TORSION OF BEAMS TORSION OF WIRES ROTATIONAL VIBRATION FLEXURE OF BEAMS YOUNG'S MODULUS TENSILE STRENGTH OF WIRES



No. 23-10

23-10 **HARCOURT T-BEAM TORSION APPARATUS** for determining the moment of torsion and the coefficient of torsional rigidity of rods of different lengths and different diameters. The above illustration shows the adaptability and interchangeability of our Universal T-Beam Series. (Section 5.)

The distinctive torsion parts consist of a ball-bearing Torsion Wheel (No. **5-1175**), in the hub of which the movable end of the rod may be centered and rigidly fixed by set screws. The other end of this rod is firmly fastened in a similar manner in the Fixed Head Torsion of Beams Attachment (No. **5-1180**). The twist on the rod so fastened is secured by weights attached to a steel ribbon wound about the flat face of the torsion wheel. The length of the rod under experimentation may be arbitrarily determined by the positions of the Index Arcs and Pointers; the former secured by movement of the clamp on the table; the latter by movement of the Pointers along the rod. The Index Arcs have interlocking attachments for use on our T-Beam Basic Clamp "A". The Pointers are fastened to the rod by set screws.

It will be noted that this design obviates errors due to slipping of the rods at the points where they are clamped.

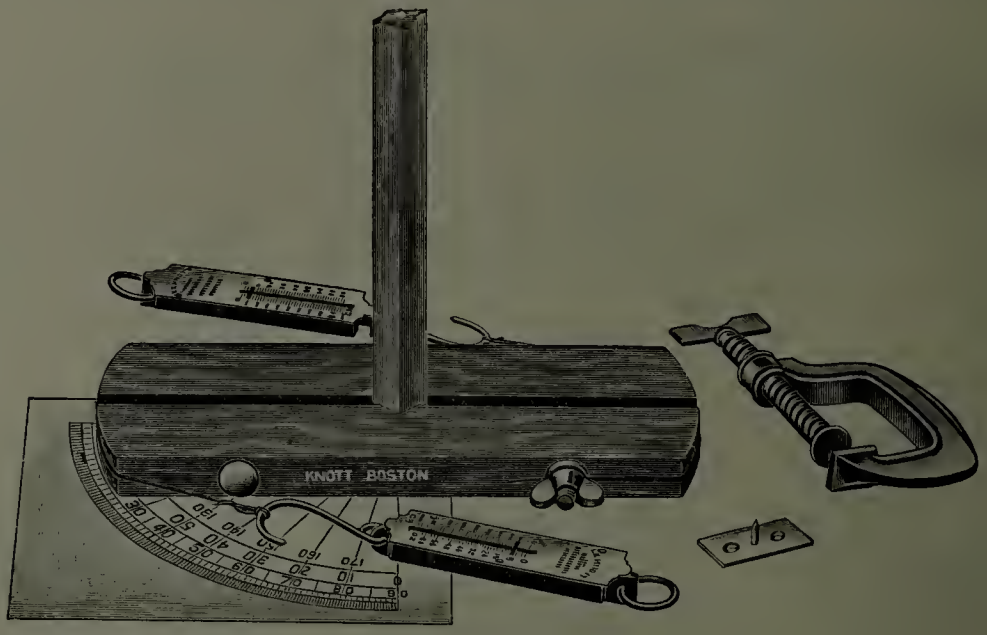
Complete apparatus, without clamps and without hanger and weights but including four rods; steel, 3 mm. and 6 mm. in diameter, brass, 3 mm. and 6 mm. in diameter **$9.15**

The Basic Clamps used in above illustration are:

5-1000 **T-BEAM BASIC CLAMP "A"** (two required) . . Each **$0.94**
5-1150 **T-BEAM BASIC CLAMP "B"** (two required) . . Each **1.65**

23-15 **HARCOURT TORSION APPARATUS.** This apparatus is the same as above in design except that the Torsion Wheel, the Fixed Head and the Arcs are cast as parts of the table clamps. It is offered to those teachers who, unfortunately, do not have in their laboratories a system of **T-BEAM BASIC CLAMPS** and **INTERLOCKING ATTACHMENTS**. Complete with four rods, — steel, 3 mm. and 6 mm. in diameter, and brass, 3 mm. and 6 mm. in diameter **13.35**

WEIGHTS. Section 16.



No. 23–30

23–30 **SIMPLE TORSION APPARATUS** for deriving laws of torsion.
Complete apparatus, as listed below, including two spring balances **$2.45**

23–30a **ASH ROD,** ½ × ½ inch . . . . . **.12**

23–30b ——, ¾ × ¾ inch . . . . . **.14**

23–30c **COMBINATION BASE LEVER** . . . . . **.60**

23–30d **GUIDE PIVOT** . . . . . **.25**

23–30e **IRON CLAMP FOR ROD** . . . . . **.35**

14–45 **QUARTER CIRCLE PROTRACTOR** . . . . . **.09**

15–310 **SPRING BALANCE** . . . . . **.45**

Nos. 23–50 and 23–52

23–50 **IMPROVED SABINE'S TORSION PENDULUM** for determining the moment of torsion of a wire and the moment of inertia of a ring.

The design illustrated obviates the annoyances of existing types. It is simple in design, self-contained, and scientific in structure and appearance. Accurate results are possible with a minimum of trouble.

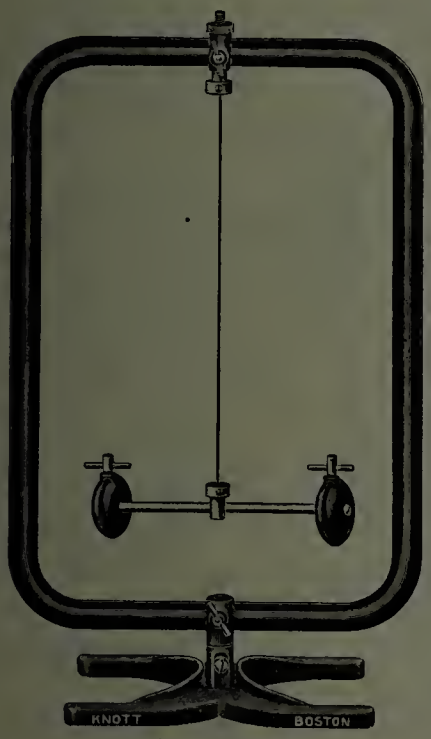
Two methods of reading torsional vibrations are possible, — by direct observation of consecutive transits of the index past the zero point of the graduated arc; by observing through a telescope the consecutive flashes from the illuminated mirror.

The disc is 10½ inches in diameter and is clamped to the wire by means of a small chuck fixed at its middle point.

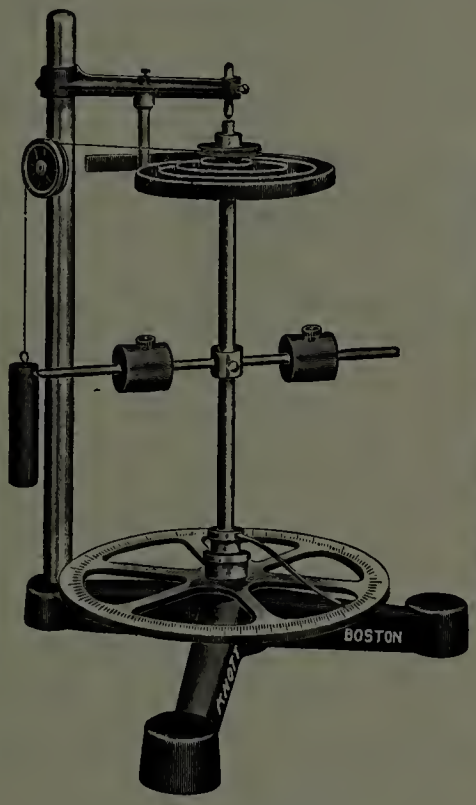
This disc is then supported from the frame by a similar chuck having the additional features of an adjusting thumb nut and a set-screw. The index dial is cast from metal and has large raised figures. A ring moment of inertia of which is to be determined has the same diameter and mass as the disc.

Torsion pendulum, as illustrated but without mirror attachment **$15.60**

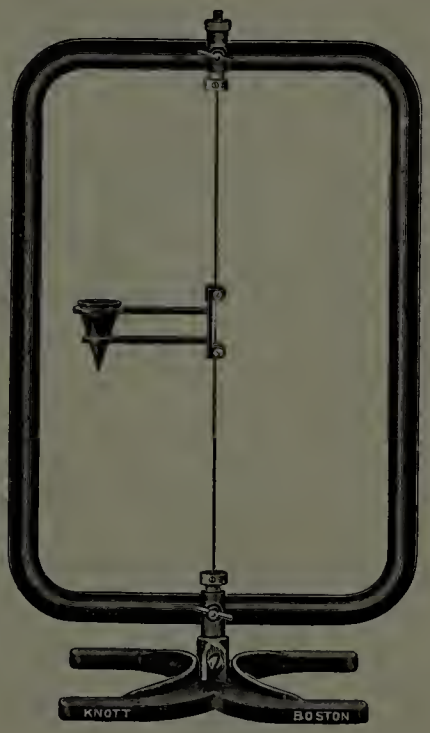
23–52 **MIRROR ATTACHMENT** complete, ready for attachment as illustrated **1.25**



No. 23–60



No. 23–90



No. 23–100

23–60 TORSION PENDULUM for determining the moment of torsion for a steel wire and the moment of inertia of two iron weights.

The apparatus consists of a metal frame mounted to one of our substantial H bases. Suspended from the central part of this frame by means of a simple chuck is the suspension system consisting of a steel wire at the end of which is mounted a cross head carrying two disc-shaped metal weights fixed adjustably along the cross head.

Complete as illustrated . . . . . $ 4.50

23–62 TORSION SYSTEM as used in above frame, all that is required if No. **23–50** or **23–100** is a part of the school equipment 2.25

23–90 HARMONIC MOTION APPARATUS for verifying the Laws of Harmonic Motion (Ames and Bliss, page 111) by noting the rotational vibrations of a flat coiled spring.

This apparatus consists of a flat coiled spring mounted on a vertical axis supported in frictionless bearings, which, in turn, carries an arm with sliding weights to vary the inertia. The oscillations are indicated by a pointer over a graduated aluminum dial. The whole is mounted on a tripod base upright supporting the vertical axis and providing a support for a rod to which one end of the spiral is fixed. Handsomely finished throughout in bright japan, lacquered brass and nickel-plate.

Complete as illustrated 22.00

23–100 INERTIA BALANCE for determining the mass of a body without weighing.

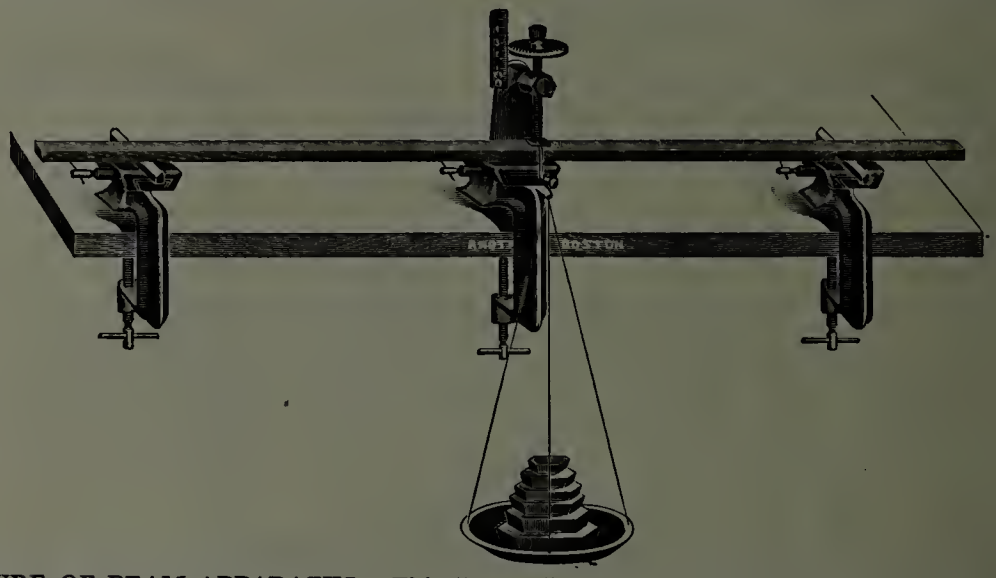
The apparatus consists of a metal frame same as No. **23–60** mounted on our improved H base. To the center of the upper and lower sides are small chucks carrying a wire the upper end of which may be adjusted in length by means of a thumb screw and firmly fixed by a T screw. This wire holds a small metal cone-shaped pan fixed to it by means of two screws. The apparatus is finished throughout in a manner to present a pleasing appearance and is carefully constructed to give the best possible results.

Complete apparatus as illustrated 5.00

23–102 INERTIA SYSTEM as used in above frame, all that is required if No. **23–50** or **23–60** is a part of the school equipment 2.75

23–105 UNIVERSAL RECTANGULAR CAST METAL SUPPORTING FRAME. Frame support only of Nos. **23–60** and **23–100** 2.25

FLEXURE OF BEAM APPARATUS



23–125 **FLEXURE OF BEAM APPARATUS.** This "set up" for determining by experiment the laws of elasticity of flexure is an arrangement of our Harcourt Universal T-Beam Clamps. (See Section **5.**)
Complete apparatus without basic clamps and weights **$5.32**

23–128 **KNIFE EDGE CONTACT PIECE.** This is a metal stirrup with knife edge, binding post and hook. With the knife edge resting on the beam, the weights, hanging to the hook, cause a stress at one point only . . . . . **.65**

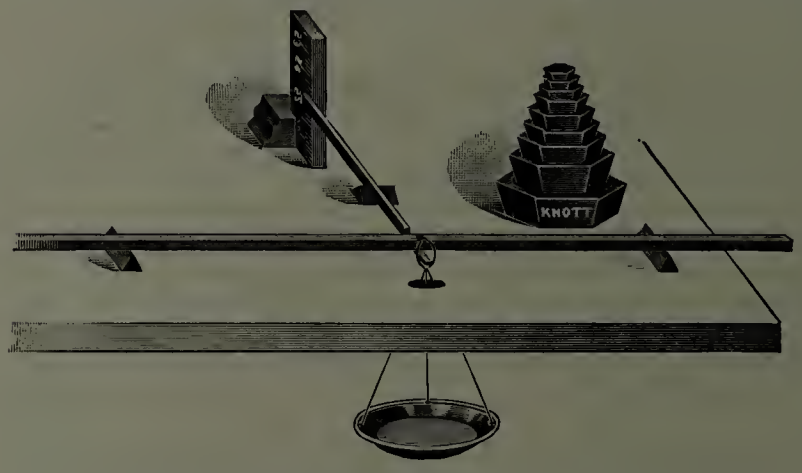
23–130 **SCALE PAN** . . . . . **.12**

WEIGHTS. Section **16.**

Other apparatus illustrated above and listed elsewhere is as follows:

5–1000 **HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "A"** (three required) Each . . . . . **.94**

23–135 **FLEXURE OF BEAM APPARATUS** same as No. **23–125** in design except that the Knife Edges are cast as parts of the table clamps and in place of the T-Beam Clamp and Micrometer Screw, the Mounted Micrometer Screw No. **12–230** is furnished. Complete without weights **5.15**



23–140 **FLEXURE OF BEAMS APPARATUS** for determining by experiment the laws for elasticity of flexure.

The apparatus consists of three triangular prisms, two of which are used to support the rod under test, the third to act as the fulcrum of the lever indicator. A vertically mounted rule gives the measure of the movement of the long arm of this lever. The scale pan attached directly over the short arm of the lever and over the rod serves as a support for the weights which cause the stress.

Complete apparatus as illustrated, without weights, including the three prisms, two pine rods of different cross sectional area, one lever indicator with supported scale and scale pan **$0.70**

23–141 **SUPPORTING TRIANGULAR PRISMS** . . . . . Per Set of Three **.24**

23–142 **PINE ROD,** 100 centimeters × ½ × 1 inch . . . . . **.12**

23–143 ——, 100 centimeters × ½ × ½ inch . . . . . **.10**

23–144 **LEVER INDICATOR** . . . . . **.08**

23–145 **MOUNTED INDEX STRIP** after Hall Ex. **14** (No. **34**) . . . . . **.10**

11–70 **MOUNTED 10-CENTIMETER SCALE** . . . . . **.16**

23–130 **SCALE PAN** . . . . . **.12**

WEIGHTS. Section **16.**

23–156 **PAIR OF WOODEN SUPPORT BLOCKS,** after Millikan, Gale and Bishop's "Laboratory Physics," Experiment **13** . . . . . **.55**

23–157 **STEEL ROD,** after Millikan, Gale and Bishop's "Laboratory Physics," Experiment **13** . . . . . **.10**

No. 23–180

23–180 HOOKE'S LAW and **YOUNG'S MODULUS APPARATUS,** for testing Hooke's Law and determining Young's Modulus for a wire.

This apparatus consists of two parallel rods supported on a tripod with leveling screws. In the upper casting clamping the rods is a small metal chuck for clamping the upper end of the wire to be tested. In a hole in the center of the movable casting is a second chuck which is set into a cylindrical brass piece which moves with very little play in this hole. This movable casting bears an accurately adjusted optical lever the front feet of which rest on a small table incorporated in the casting. The rear foot rests upon the carefuly ground top surface of the brass piece bearing the chuck. Three two-kilogram and two one-kilogram weights which are supplied with the apparatus may be placed on the weight hanger to give the stretching force.

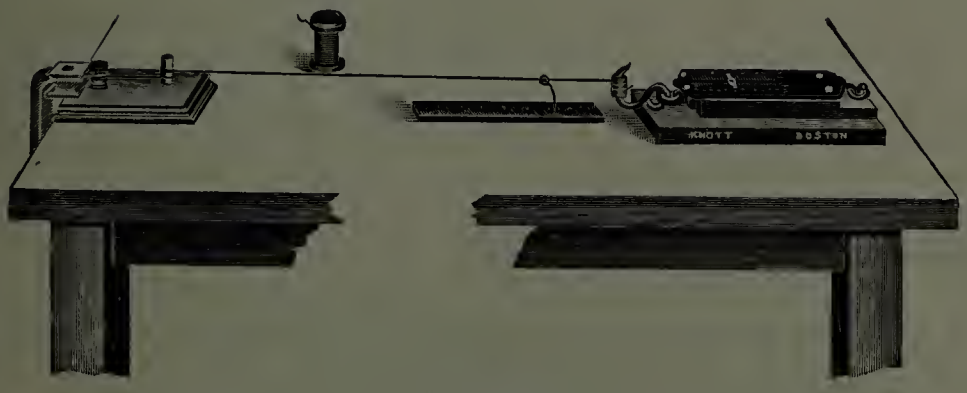
This apparatus is solidly built and its structure is of most painstaking type. Accurate results are easily obtained.

Complete as described **$25.00**

23–191 MIRROR SCALE and **UPRIGHT WOODEN-SUPPORT** after Millikan, Gale and Bishop (Experiment **13**) . . . . . **.80**

23–192 SPRING and **WEIGHT HOLDER** after Millikan, Gale and Bishop (Experiment **13**) . . . **.20**

Nos. 23–191 and 23–192



No. 23–225

23–225 ELASTICITY OF WIRE APPARATUS, for determining the Coefficient of Elasticity of Wire.
Complete apparatus as above illustrated, but without Spring Balance and Basic Clamp **$2.15**

SEPARATE PARTS.

23–226	**SPOOL SPRING BRASS WIRE,** No. 27	**$0.40**
23–227	**T. & H. STRETCHING BLOCK WITH WOOD PILLAR AND BRASS BINDING POST** . . .	**.90**
23–228	**MARKER CLAMP AND STYLUS**	**.20**
5–1150	**T-BEAM BASIC CLAMP "B"**	**1.65**
15–315	**SPRING BALANCE,** 15 kilos and 30 pounds	**1.65**
23–231	**MOUNTED MILLIMETER SCALE**	**.20**
15–365	**SPRING BALANCE SUPPORTING CRADLE**	**.45**

No. 23–212

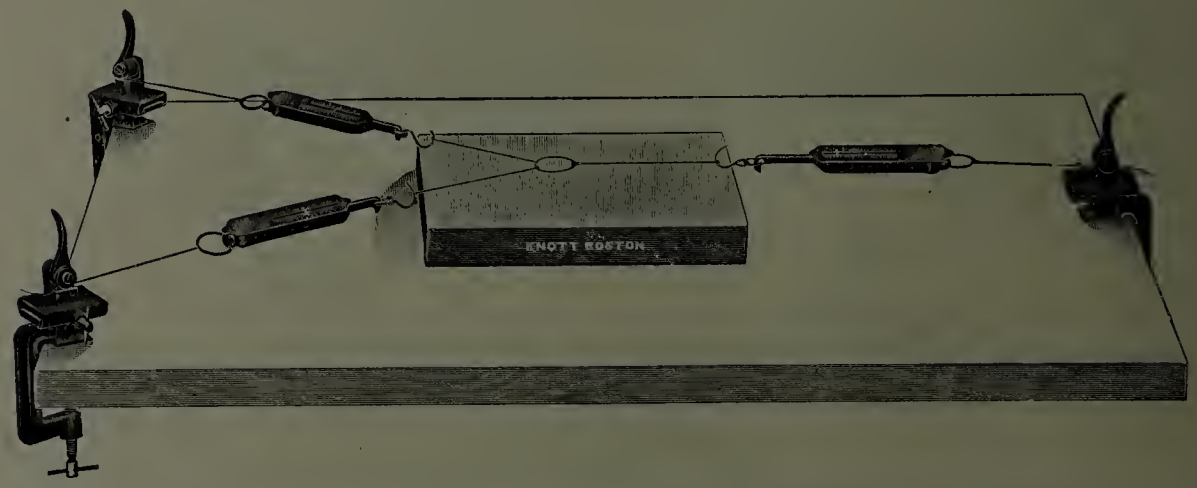
23–211 BREAKING STRENGTH OF WIRES APPARATUS, for measuring the tensile strength of wires. This apparatus must not be confused with the various forms on the market. It is designed to do all and more than the others will do, and to facilitate rapid and accurate determinations. It is constructed entirely of metal. The essential features consist of cast metal legs, to which are rigidly fastened two nickel-plated steel rods to form the bed of the instrument. To the bed are clamped the cradle for the dynamometer and a recoil frame. The ring of the dynamometer slips over a peg on one of the end castings. The hook is attached to the recoil frame. The design of this recoil frame is simple and most effective. It is a metal casting provided with binding device for one end of the wire whose tensile strength is to be tested and the retaining frame with buffer for recoil wedges. Our tension device consists of a crank operating an axle about which the wire winds as the tension increases. Danger of recoil of crank is entirely obviated by means of a rachet and pawl attached to one end of the axle.

Results of experience have demonstrated that in this design we offer an instrument obviating objectionable features of less carefully and scientifically designed instruments. Our instrument will form a valuable acquisition for any well appointed laboratory.

Without dynamometer **$5.00**

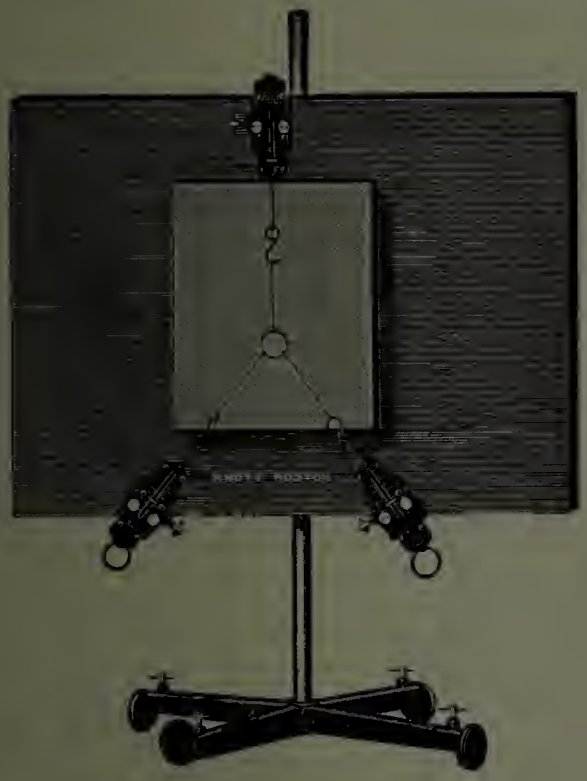
23–212 ——, same as above, but with double scale dynamometer, 30 pounds and 15 kilos **6.60**

COMPOSITION OF FORCES



For the "set up" of the experiment above illustrated no new apparatus is required. Articles shown above are as follows:

5–1000	**HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "A."** (Three needed)	Each	**$0.94**
5–1065	**STONE'S TENSION CLAMP ATTACHMENT.** (Three needed) . .	Each	**.48**
15–310	**SPRING BALANCE,** 2000 grams and 64 ounces. (Three needed) . .	Each	**.45**



The only distinctive item shown in accompanying illustration is the following:

24–15 STRAIGHT-GRAINED SUPPORT BOARD with side ledges and provided with clamp at back for attaching to any 19-millimeter rod . **$2.20**

Other apparatus illustrated has all been previously listed as follows:

5–1000 HARCOURT T-BEAM BASIC CLAMP "A." (Three required) . . . . . Each **.94**

5–1070 BALANCE CRADLE ATTACHMENT. (Three required) . . . . . Each **.66**

5–250 KNOTT ADJUSTABLE ECCENTRIC LEVELING BASE **2.35**

5–20e SUPPORT ROD, 19 millimeters diameter, 100 centimeters long **1.00**

NOTE. — Universal Stand No. **22–130** may be used in place of the last two items if so desired.

24–25 COMPOSITION OF FORCE ATTACHMENT for use on any 19 millimeter rod in the study of equilibrium and composition of forces. This attachment consists of a metal casting with clamp and cross-head in one piece. The cross-head is provided with hooks for hanging pulleys.

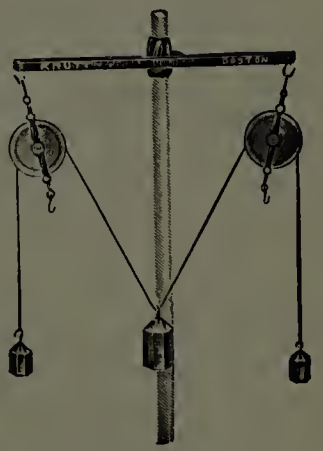
Attachment only, without pulley or weights illustrated **$1.15**

ACCESSORY APPARATUS ELSEWHERE LISTED:

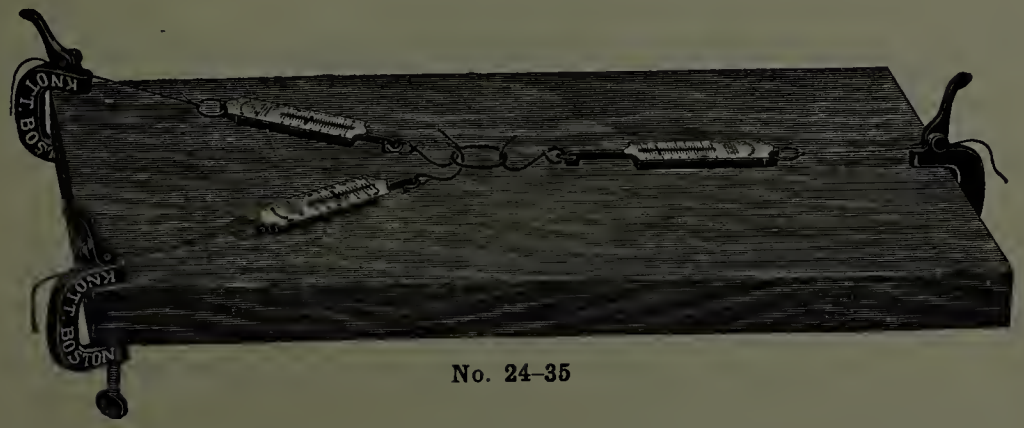
22–130 UNIVERSAL STAND **$2.10**

27–150 BALL-BEARING SINGLE PULLEY. (Two required) Each **.60**

16–450 UNIVERSAL WEIGHTS . . . . . Set with holder **2.75**



No. 24–25

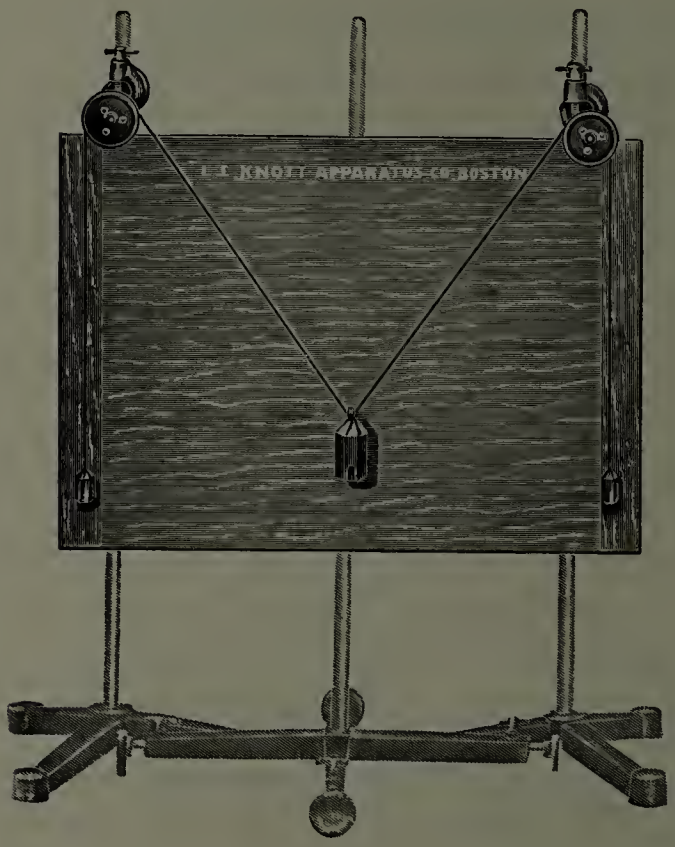


No. 24–35

24–35 STONE'S TENSION CLAMPS for holding either a string or wire firmly yet adjustably; convenient for use with Spring Balances as illustrated in determining the Parallelogram of Forces.

This clamp consists of a casting with jaws wide enough to fit over the ordinary Physics Laboratory Table. A nickel-plated T-screw is provided for firmly fixing to the table. The wire is threaded under a small cam lever which binds or releases by only a slight motion of the lever. Per set of three **$1.14**

24–36 STONE'S TENSION CLAMP . . . . . Each **.38**



No. 24–60

COMPOSITION OF FORCES

Items above illustrated assembled will all be found previously listed, and if already a part of the school equipment will not be needed. They are as follows:

5–250	**KNOTT ADJUSTABLE ECCENTRIC LEVELING BASE**		**$2.35**
5–20e	**SUPPORT ROD,** 19 millimeters diameter, 100 centimeters long		**1.00**
22–130	**UNIVERSAL STANDS.** (Two required)	Each	**2.10**
5–770	**RIGHT-ANGLE CLAMPS.** (Two required)	Each	**.95**
5–952	**PULLEY ON ROD.** (Two required)	Each	**.90**
16–450	**UNIVERSAL WEIGHTS**	Per Set with Holder	**2.75**
24–15	**SUPPORT BOARD**		**2.20**

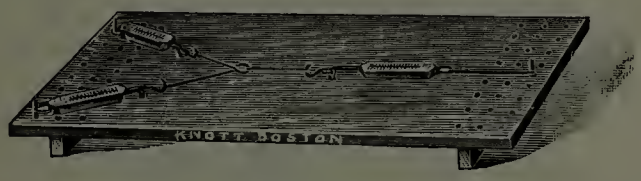
24–60 PARALLELOGRAM OF FORCE TABLE for use in either **HORIZONTAL** or **VERTICAL POSITION** in deriving Laws of Parallelogram of Forces.

This instrument is intended for high-grade work in the quantitative determinations of the Laws of Parallelogram of Forces. Built throughout of metal, it is extremely substantial, and being beautifully nickeled and japanned, presents a handsome appearance. The apparatus consists of a smooth nickeled iron disc 35 centimeters in diameter, divided into degrees. It is mounted in such a manner that it can be used in either a vertical or horizontal position. Frictionless bearing brass pulleys are provided for attachment to the edge of the disc. By the use of a special centering arrangement, weights and weight holders, very accurate results are possible with this table.

Complete as illustrated, with three frictionless bearing brass pulleys, centering arrangement, weights and weight hangers, mounted on a 60-centimeter rod on tripod base **25.00**

24–61 PARALLELOGRAM OF FORCE TABLE, same as No. **24–60,** but mounted on a 100-centimeter rod and with tripod with three leveling screws **26.00**

WEIGHTS AND WEIGHT HOLDERS. Section **16**



No. 24–80

24–80 COMPOSITION OF FORCE BOARD, as used in Millikan, Gale and Bishop's "Laboratory Physics" (Experiment **11**).

This is a well-seasoned board, 30 × 19½ inches, to the back of which are fastened two strips of wood, which serve the double purpose of preventing warping and as a support. They are of sufficient length so that the board may rest vertically. Holes into which pegs may be placed are conveniently located on each quarter surface of the board, thus providing a convenient setting for a pin to which strings from a Spring Balance may be attached.

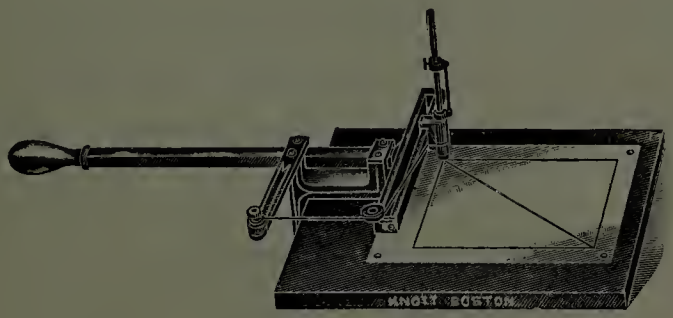
The Board, with three pegs, but without Balances **$1.60**

24–87 COMPOSITION OF FORCE BOARD for use with Spring Balances in formulating the laws of Composition of Forces.

This apparatus consists of a square board constructed so as to prevent warping, with holes equally spaced in squares. Pins are provided which may be placed in any hole desired, to which may be attached the strings from the hooks of Spring Balances. That the board may move freely, four spheres are provided, which, when placed next to the retaining rims on the under side, will act as ball bearings. This board has a sandpaper and oil finish and is substantially built throughout.

Board with four pegs and four balls **1.55**

24–95 WIRE PENTAGON, after Turner and Hersey (Experiment **M274**) . . . . . **.15**



No. 24–100

24–100 GAGE'S COMPOSITION OF FORCE AND MOTION APPARATUS for the graphic representation of the components and resultant of two forces.

The apparatus consists of a flat board to which is clamped an attachment consisting of a clamp holding in a sliding fit a square rod, with cross head which in turn carries a slide with pencil clamp. This pencil clamp is free to move along a rod parallel to the cross head and is connected by a string around a pulley to the end of the arm attached to the clamp holding the apparatus to the board.

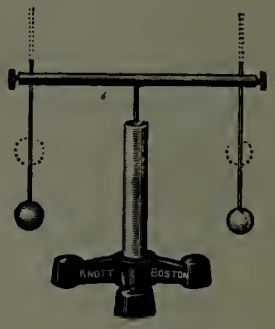
Results possible with this apparatus arouse the interest of pupils in the Resolution of Forces. It is pedagogically superior to much that is on the market for the graphic representation of forces.

Complete as illustrated **$9.75**

FORCE OF GRAVITATION

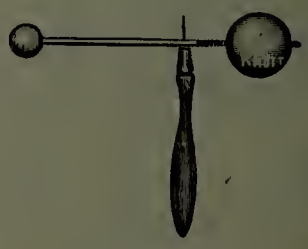
EQUILIBRIUM — Stable, Unstable and Neutral

No. 25–10



No. 25–15

No. 25–55



No. 25–20

No. 25–50

25–10 CENTER OF GRAVITY BOARD for determining the center of gravity of an irregularly-shaped board.
This apparatus consists of a board of irregular shape drilled at various points. If the board is held suspended from these several points, and a plumb line dropped from each, it will be found that these lines all intersect at one point, — the center of gravity.
Board complete with handle support and plumb bob $0.95

25–15 MOUNTED CENTER OF GRAVITY ARC for illustrating stable and unstable equilibrium.
This apparatus consists of a balanced system so designed that the center of gravity may be readily adjusted to demonstrate stable, unstable and neutral equilibrium.
Complete as illustrated, with supporting stand 1.35

25–20 CENTER OF GRAVITY SYSTEM for illustrating the center of gravity.
The apparatus consists of two brass spheres of different sizes connected by a rod in which are drilled two holes, one at the geometric center, the other at the center of gravity. A support handle is supplied with each instrument.
Complete as illustrated 75

25–50 LOADED CYLINDER WHEEL for illustrating the center of gravity of a loaded wheel.
This apparatus consists of a wooden disc loaded near the edge and drilled at the geometric center and at the center of gravity. A suitable upright for support is also furnished 1.20

25–55 LOADED CYLINDER, illustrating the tendency of a body to place its center of gravity as low as possible.
This is a wooden cylinder loaded eccentrically, which, if rolled along a horizontal surface, will strive to rest on its loaded side 30

25–60 WITCH, illustrating the tendency of a body to keep its center of gravity as low as possible.
This apparatus consists of a hemispherical piece of metal to which is attached a short length of pith. .11

25–75 LEANING TOWER, illustrating stability when a line drawn through the center of gravity comes within base of support.
This inexpensive device, illustrative of the celebrated Leaning Tower of Pisa, is built of wood with a removable top and foot. With the foot in place, the tower will stand so that its center of gravity is in center of circle of the base. With foot removed and top in place, the center of gravity being without the base, the tower will topple over. With top taken off, the tower will stand stable, the center of gravity coming within the base $1.20

No. 25–75

No. 25-80

25–80 HORSE AND RIDER, illustrating equilibrium when line drawn through the center of gravity comes within base of support.
The apparatus consists of wooden figures representing a horse and rider. A wooden ball is attached to the figures so that its weight changes the center of gravity to come within the base of support. A striking illustration of the principle is possible as pictured 95

FALLING BODIES

ACCELERATED MOTION

No. 25–100
Patented December 17, 1907

25–100 **PACKARD'S FALLING BODY APPARATUS** for the determination of the Laws of Accelerated Motion with their application to falling bodies, the data being obtained from the path that the falling body traces during descent.

This ingenious invention of Mr. John C. Packard of the Brookline High School, Brookline, Mass., is, in its fundamental principle, a greatly improved inclined plane. It consists of a board of a design to meet the special requirements. A quick-acting spirit level is attached for obtaining the necessary plumb in one plane. Adjustable legs at one end afford facilities for varying the angle of tilt for changing the conditions. In use, a steel ball is allowed to roll down over the smooth surface of a sheet of paper covered with a soft carbon tracing paper. There will be found on the board, effective devices for clamping the paper and for holding and releasing the ball as required. Results obtained by even the most careless students are ample recommendations for the purchase of this instrument.

Complete with 12 sheets Cross-section Paper and 2 sheets Carbon Paper. Special circular on request **$6.25**

25–101 **CROSS-SECTION PAPER,** special ruled . . . . . Per Ten Sheets **.30**

25–102 **CARBON PAPER,** especially adapted for use with No. **25–100** . . . . . Per Sheet **.07**

25–105 **DUFF'S ACCELERATION APPARATUS,** designed by Dr. A. Wilmer Duff of Worcester Polytechnic Institute, for determining the acceleration of a falling body.

The apparatus consists of an accurately grooved plank. With the plank placed horizontally on the table, a steel ball placed on one end of the groove will, when released, oscillate back and forth like a pendulum and the time of each swing will remain constant. If, however, one end of the plank be raised a little higher than the other, a ball placed in the middle of the groove will roll down with accelerated motion.

By combining the oscillatory motion across the groove with the accelerated motion down the incline, the oscillatory motion may be made to trace in a film of lycopodium powder equal intervals of time for the study of accelerated motion.

Grooved Plank complete with Sphere, Releasing Block and package of Lycopodium Powder . . . **5.25**

No. 25–140

No. 25–120

Nos. 25–110 to 25–112

Nos. 25–161 and 25–165

25–110 **FALLING BODY APPARATUS,** retardation to free fall secured by **INCLINED PLANE** according to Millikan and Gale's "A First Course in Physics," page 26, for determining the distance traversed by a body under force of gravity in one, two, three, or four seconds under uniformly accelerated motion.

The apparatus consists of a clear, straight-grained wooden plank, 16 feet long, with accurately cut V groove running the total length, which, when inclined at an angle, affords an inclined plane down which a steel ball may roll in a frictionless path. A block stop for this ball is furnished which may be clamped to the plane at any position desired. Time interval may be noted by any convenient means. We recommend either a Seconds Pendulum No. **17–50,** or a Metronome No. **17–120** **$8.60**

25–112 ——, same as above, but 8 feet long. This is to be used in connection with above for measuring velocity acquired per second by a body under force of gravity in uniformly accelerated motion . . **4.80**

25–120 **FOUR-FOOT FREE FALL DEMONSTRATION APPARATUS or GUINEA AND FEATHER TUBE** for demonstrating that all bodies, even if of different masses, fall in equal intervals of time if released from friction of air pressure.

This apparatus consists of a large glass tube, one end sealed air-tight, the other end with a brass cup with stop-cock, bodies of different masses being enclosed previous to sealing **6.75**

25–140 **THE IMPROVED ALL METAL FALLING BODY APPARATUS** (Ames and Bliss' "A Manual of Experiments in Physics," Experiment **21**), for determining the velocity and acceleration of a freely falling body.

The apparatus consists of a weighted glass plate free to slide in a vertical metal frame. The nickel-plated support rod may be adjusted to accommodate different sizes of forks and the clamp adjusted to vary the height of the fork on the rod.

In use, the plate is covered with an even layer of smoke soot, "Bon Ami," or whatever is desired to give it a tracing surface. A fork with attached stylus is fastened in the clamp and adjusted so that the stylus will mark the plate as it is allowed to drop from the top of the upright frame.

Price, without fork **6.90**

TUNING FORKS. See Section **51.**

25–161 **ACCELERATION APPARATUS** for determining the acceleration of a freely-falling body moving with uniformly accelerated motion.

The falling body is a metal frame to which a heavy glass plate is held by spring clamps. This metal frame with its glass plate falls before an electrically driven tuning fork, of known vibration number and which may be moved sideways to enable one plate to take several readings.

In making an observation the plate is drawn to the top of the frame and fastened by a thread. The stylus is now adjusted to touch the plate. The tuning fork is set in vibration, the string is burned in two and the descending plate receives a fine tracing on its blackened or whitened surface. Measurements are taken directly from the plate by means of a divider or scale. Frequently the tracing is projected on a screen by means of a lantern.

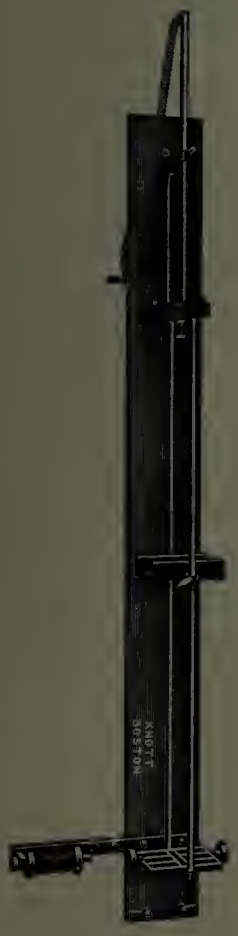
The apparatus may be used as an Atwood's Machine by attaching a light aluminum wheel on ball-bearings to the frame. This wheel carries a cord holding the falling plate on one end and the counterbalancing weights on the other. The platform and ring may be easily attached to the frame.

Complete without Atwood's Attachment $25.00

25–165 ATWOOD'S ATTACHMENT for use with No. **25–161** and as illustrated 15.00

NOTE. — The glass plate of Acceleration Apparatus No. **25–161** is generally coated with lamp-black over a gas-jet or burning camphor. A much more cleanly method will be found in making a thin paste of alcohol and whiting, which may be rapidly applied to the plate with long strokes of a camel's-hair brush or a soft sponge.

No. 25–200



No. 25–180

25–180 FREE FALL APPARATUS (Stewart and Gee's "Elements of Practical Physics," page 239), for finding the time taken by a body falling freely from a height, and in determining the value of "g."

The factors in determining the value of "g" are determined by the free fall of a steel sphere from the bronze-tipped electro-magnet at the end of a vertically adjustable brass rod to a slit at the lower end of a pendulum whose period may be varied. The position and width of the slit is adjusted so that the sphere dropping vertically passes through it when the pendulum is at its lowest point. The electro-magnet holding the sphere and the one drawing the pendulum aside are in the same circuit, which, when opened, releases both simultaneously. If the time of fall equals the quarter period of the pendulum, the sphere passes through the slit. By raising or lowering the brass rod, this equality may be easily produced. One jaw is covered with lead, in order that the experimenter may determine by ear whether the sphere arrives at the plane of the slit too soon or too late. The period of the pendulum gives the time of the fall. The distance is measured from the bottom of the suspended sphere to the plane of the slit.

We unhesitatingly recommend this apparatus for very accurate determinations of "g" $25.00

25–200 UNIFORMLY ACCELERATED MOTION APPARATUS for study of principles of accelerated motion and for determination of factors governing a body under uniformly accelerated motion.

The apparatus consists of a car which, mounted on a wire inclined at a slight angle, is free to move down the incline. The wire is provided with a hook at one end and a turn-buckle at the other for securing taut wire.

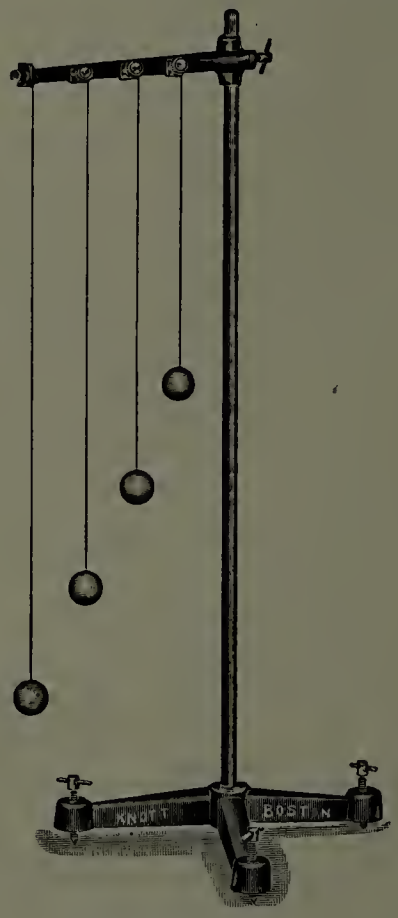
Apparatus complete as illustrated 3.40

25–201 LYON'S CAR, with buffer 1.95

25–202 INCLINED-WIRE OUTFIT, including screw, hooks, and turn-buckle with buffer 1.45

25–210 HALL'S ACCELERATION APPARATUS according to Hall's "Elements of Physics," Exercise **17,** page 508, 1912 edition. Pendulum Bar with Counterpoise and Support as described 1.75

PENDULUMS



No. 25–225

No. 25–230

25–225 **FOUR BALL PENDULUM ILLUSTRATION** for determining factors governing the laws of pendulums.

The apparatus illustrated must not be confused with similar designs on the market, as it will be noted that our instrument will support in adjustable suspensions four pendulums.

Pendulum Clamp with four balls but without support $1.95

5–900 **FOUR PENDULUM CLAMP** only 1.75

Support illustrated is No. **22–131 UNIVERSAL STAND** 3.15

25–227 **THREE BALL PENDULUM ILLUSTRATION,** same as above, but with our No. **5–902** Pendulum Clamp for holding three pendulums in adjustable suspensions.

Pendulum Clamp with three balls but without support 90

5–902 **THREE PENDULUM CLAMP** only 75

25–230 **PENDULUM APPARATUS,** after Turner and Hersey, for the determination of the Laws of the Pendulum.

The apparatus consists of a special pendulum clamp, details of which are shown in illustration, each designed to hold two pendulums. For different masses, we list three bobs of different metal; for suspensions, fine wire.

In use, the pendulum clamp is attached by means of an iron clamp (our No. **5–1150** Harcourt Basic Clamp "B" being shown in the illustration) to a convenient support, the Cross Beam of our Standard Physics Table No. **1–100,** being illustrated.

Apparatus complete without Basic Clamp 1.74

SEPARATE PARTS

25–230a **PENDULUM CLAMP** as used in above $0.54

25–230b **SPECIAL CYLINDRICAL IRON BOB** 25

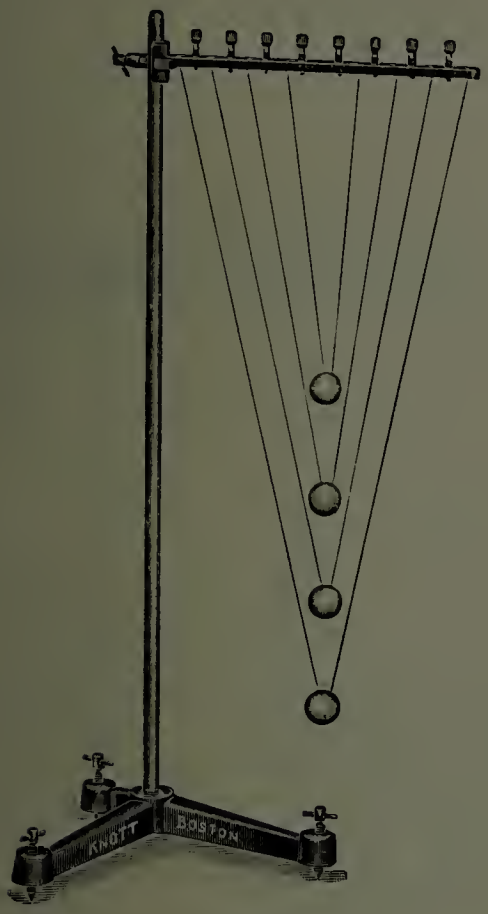
25–230c **SPECIAL CYLINDRICAL LEAD BOB** 30

25–230d **SPECIAL CYLINDRICAL BRASS BOB** 30

25–230e **SPOOL COPPER WIRE,** No. **30** 35

5–1150 **HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "B"** 1.65

25–232 **SIMPLE AND REVERSIBLE PENDULUM APPARATUS,** after Hall (No. **XLIV**), complete with bobs but without meter stick 1.95



No. 25–235

No. 25–251A

No. 25–260

25–235 BI-FILAR FOUR PENDULUM ILLUSTRATION for determining factors governing the Laws of Pendulums.

This apparatus consists of our No. **5–905** Pendulum Clamp with four balls of equal diameter. These balls are attached to the clamp by threads of lengths to obtain vibration periods, as 1: 2: 3: 4.

Pendulum Clamp with four balls, but without illustrated support **$2.95**

5–905 BI-FILAR PENDULUM CLAMP only **2.35**

Support illustrated is

22–131 UNIVERSAL STAND **$3.15**

25–251 CULLER'S ADJUSTABLE LEVER, PULLEY AND PENDULUM CLASP AND HOOK ROD after Dr. J. A. Culler, Miami University, Oxford, Ohio. The name of this ingenious device is descriptive of its manifold uses. (See Experiments **VII**, **X** and **XI** of Culler's "Laboratory Manual of Physics".) Clasp and Hook Rod only **1.60**

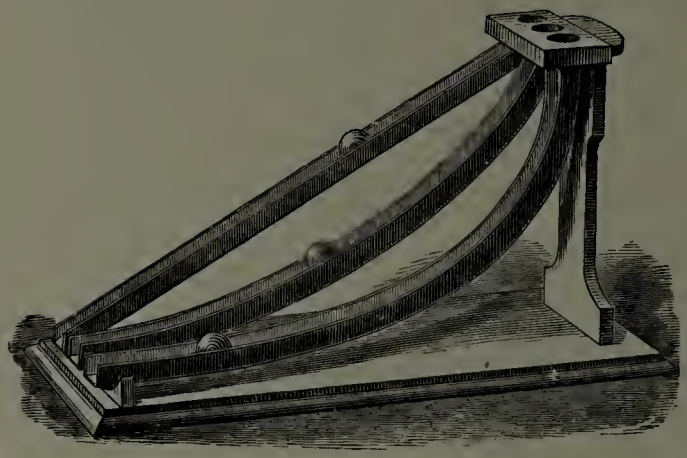
25–251A ——, with Clamp **2.40**

25–260 REVERSIBLE PENDULUM for determination of centers of suspension and oscillation, and, by measurement of the distance between these centers, to determine the length of the equivalent simple pendulum and, from this, the value of the acceleration of gravity.

This design consists of a nickel-plated metal rod on which are two lens-shaped bobs, each provided with steel knife-edges with the edges of one turned towards the edges of the other. These bobs may be adjusted along the rod as desired, thus changing the centers of suspension or oscillation at will. The pendulum is suspended on the knife-edges of one of the discs on the bracket and stirrup, as above illustrated. The bobs are now fixed at such a distance apart that the pendulum vibrates with the same period, whether it is suspended from knife-edges of one bob or the other, — the center of suspension becoming the center of oscillation when the pendulum is reversed. The distance then between the knife-edges is the length of an equivalent simple pendulum.

Reversible Pendulum complete with stirrup and bracket **4.45**

GRAVITY AND MOTION



No. 25–310

No. 25–320

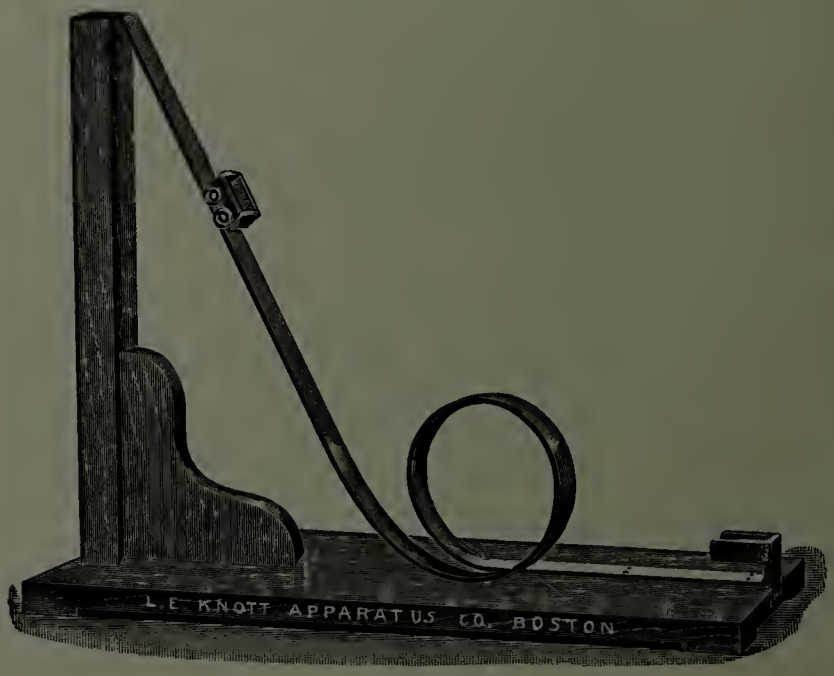
25–310 SWIFTEST DESCENT APPARATUS, comparing descents of spheres of the same diameter along inclines of different curvatures.

The apparatus consists of three tracks placed on an incline to the base line, — one track describing a cycloid curve, the second a concave circular curve, the third an inclined plane. The apparatus is further provided with a device for the simultaneous start of all three spheres. The singular results follow a simultaneous start of all three spheres, — the sphere on cycloidal curve reaches end of track first, on concave circular track second, while the one on the inclined track is the slowest. One other striking experiment will be noted, — no matter from which point on the cycloidal track the sphere is started, the time of descent to the end of the track will always be the same.

Complete with three steel spheres **$21.25**

25–320 DOUBLE CONE AND PLANE for illustrating the seemingly paradoxical phenomenon of a cone moving up an incline, which is of such shape that its axis actually descends.

Complete as illustrated, of finely grained and neatly polished wood **1.15**



No. 25–330

25–330 CENTRIFUGAL RAILWAY, illustrating the opposition offered by a moving body to any influence exerted to counteract its tendency to move in a straight line.

This apparatus consists of a looped circular railway down which a body may roll unobstructed. At one point in the loop illustrated, the body is held by centrifugal force against the under side of the track in opposition to the force of gravity.

Complete as illustrated with car **$17.50**

WAVE MOTION

No. 26–10

26–10 UNIVERSAL WAVE MOTION APPARATUS, modification of Powell's and Snell's designs, combining features of both into one instrument capable of demonstrating all principles of each. Thus the combination transverse and longitudinal component illustrating waves on surface of a liquid, wave motion as set up by transverse displacements, and wave motion as set up by longitudinal displacements are all strikingly shown.

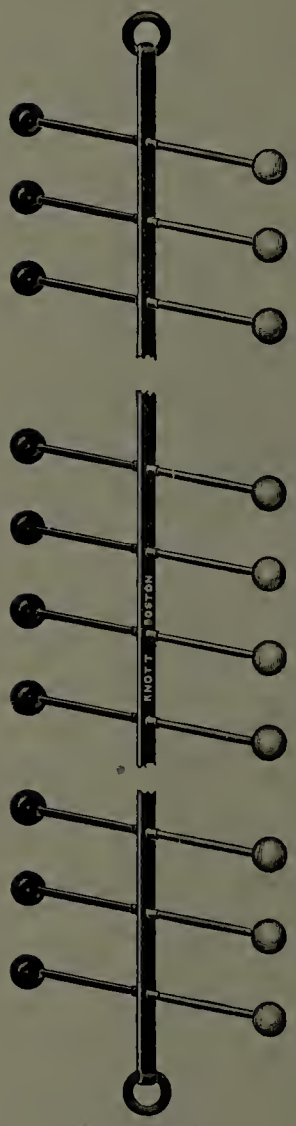
WATER WAVES. In our model we show that the particle or element on the crest moves forward, in the trough backward, and in the intermediate positions both vertically and horizontally. The elliptical or circular orbits of the disturbed particles are ample in size that they may be readily observed by all even in the largest lecture hall. It may also be shown that the wave form is not a sine curve.

TRANSVERSE WAVE FORM. The demonstration of movement of a particle transversely and the transverse wave form as well as the analysis of the resultant sine curve is especially adapted to this model.

LONGITUDINAL WAVE FORM. Our model is so designed that in demonstrating any of the above forms the condensations and rarefactions set up by longitudinal vibrations will also be formed, thus affording a striking comparison of wave forms.

This model stands about three feet high and all parts are so proportioned that it is especially adapted for lecture purposes. The elements are represented by balls; vibrations, transverse or longitudinal, are communicated by brass rods; and the vibrations are set up in the rods by means of peculiarly cam-shaped castings eccentrically mounted, each rod to its own casting, and all on a shaft operated by a single crank. When the rectangular guide frame "A" is in the position illustrated both transverse and longitudinal wave motions are demonstrated. With "A" in position as indicated by dotted lines water waves and longitudinal waves are demonstrated.

This apparatus is carefully assembled and all parts accurately made. All woodwork is neatly finished and the whole presents a scientific and handsome appearance **$65.00**



No. 26–20

26–20 WAVE APPARATUS for illustrating the formation of transverse and longitudinal waves.

This model consists of a steel ribbon along which, at regular intervals, are securely fixed cross heads bearing at either end a metal ball, rod and balls on either side of the ribbon being painted a distinguishable color that various wave forms may be easily differentiated. This steel ribbon in use is firmly fixed to the ceiling by means of the heavy screw-eye furnished with the apparatus. By giving lowest the cross-bar a motion at right angles to the steel ribbon a motion is communicated to each cross-bar in' turn, illustrating transmission or propagation of transverse waves. Longitudinal waves are propagated in similar manner by depressing one end of the lowest cross-bar in a vertical direction, the motion thus being communicated throughout the entire length.

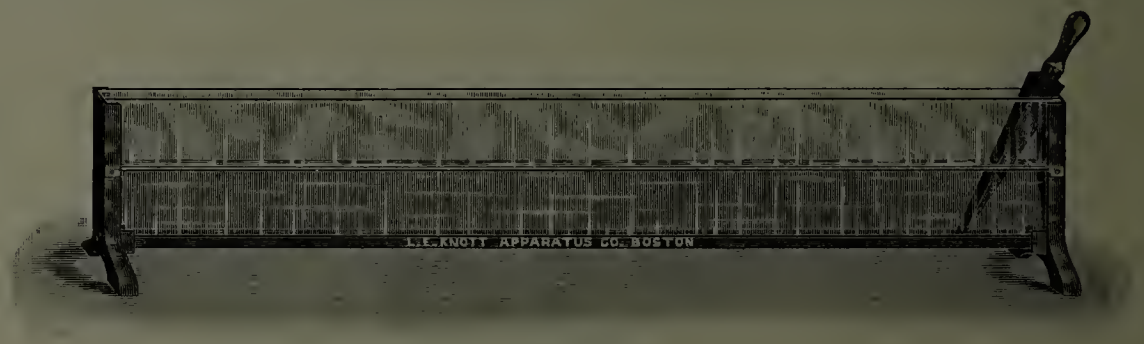
The use of this wave model fully warrants the expense, as results obtained are entirely satisfactory and may be seen from the rear of the largest lecture hall. The model is about 13 feet long, with cross-bar attached every five inches **$11.50**

No. 26–29

26–29 SPIRAL SPRING for illustrating wave motion, either transverse or longitudinal.

This spring is constructed of spring brass wire coiled in the form of a spiral **$1.25**

26–32 RUBBER CORD for illustrating wave motion . . . . . **.66**



No. 26–40

26–40 METAL-FRAMED WAVE TROUGH for illustration of water waves. The plate glass sides of this trough are supported by and sealed to the end metal castings and metal base to form a trough 10 inches deep by 5 feet long. The water level line is accurately parallel to the base. Waves are set in motion by means of the paddle illustrated.

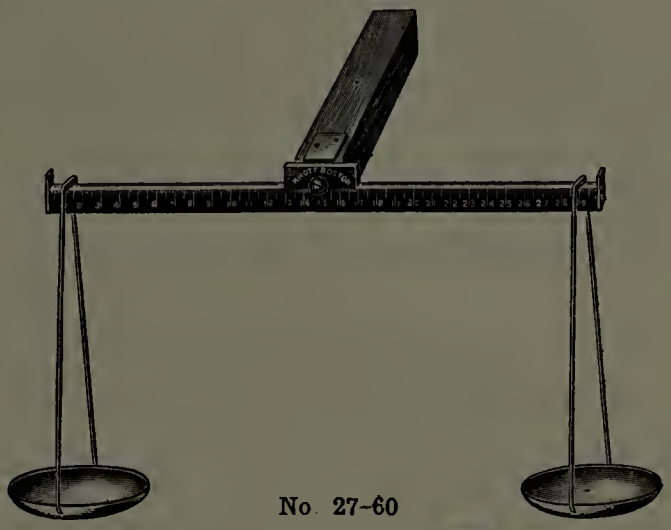
This trough, framed of metal, is vastly superior to designs framed of wood, in that possibility of warping and, therefore, leakage, is entirely obviated. It is much more substantial and the metal offers a surface for a durable and handsome japanned finish.

Complete, with paddle **$14.25**

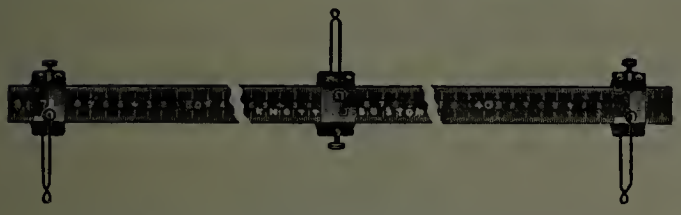
SIMPLE MACHINES

LEVERS, PULLEYS, WHEEL AND AXLE, INCLINED PLANE, WEDGE, SCREW

No. 27–30



No. 27–60



No. 27–45 (Showing Lever of the First Class)

No. 27–45

27–10 COEFFICIENT OF FRICTION APPARATUS for the study and determination of the Coefficient of Friction.
The apparatus consists of a carefully planed white wood strip, 50 × 20 centimeters. The friction between this surface and the face of a wood block, 7.5 centimeters square, is determined by means of a Spring Balance.
With Spring Balance $1.37

27–11 WHITE WOOD STRIP, 50 × 20 centimeters $0.45
27–12 WOODEN BLOCK, 7.5 centimeters square 12
15–300 SPRING BALANCE, 250 grams and 8 ounces 80
27–30 DEMONSTRATION LEVER, illustrating simple balances and also for experimental use as a lever of the first, second, or third class.
Complete apparatus as illustrated, including pointer, two of No. **27–45** and central knife-edge but without Meter Stick 1.74
27–45 KITTREDGE LEVER CLAMPS for use with an ordinary Meter Stick in determining the Mechanical Advantage of a Lever.
This clamp is made up of two metal stampings riveted together to form of meter stick and which may be clamped to it by means of a thumb screw. A knife-edge protruding on each side offers a frictionless support for the loops of a stirrup for attaching weights or hook of the scale pan. Per set of Three .60
27–60 LEVER APPARATUS for the study of Mechanical Advantages of a Lever.
The apparatus consists of a wooden bar to which is attached a graduated movable cross head with metal retaining ends. Complete as illustrated, with a pair of scale pans with improved knife-edge bearings after Mr. W. E. Rice 1.30
27–61 LEVER AND SUPPORTING BAR only 55
27–61a STRAIGHT LEVER 35
27–61b SUPPORTING BAR and PIVOT 20
27–62 RICE SCALE PANS . . . . . Per Pair .75
27–67 SCALE PANS, ordinary grade with attached strings . . . . . Per Pair .40
27–75 RIDER BLOCK, after Hall and Bergen (Experiment **12**), for use on meter stick in determining Weight of Lever Arms 18
27–80 U-SHAPED WIRE SUPPORTING HOOK, after Turner and Hersey (Experiment **M130**) 08
27–95 COMPOUND LEVER, illustrating a combination of simple levers to secure power equivalent to a simple lever with long arm.
The apparatus consists of two lacquered brass strips connected and mounted on a convenient wooden base 4.50
27–100 STEELYARD, capacity 50 pounds 1.25

For other **COMPOUND LEVERS,** see Section **29.**

PULLEYS

NEW FORM PULLEYS

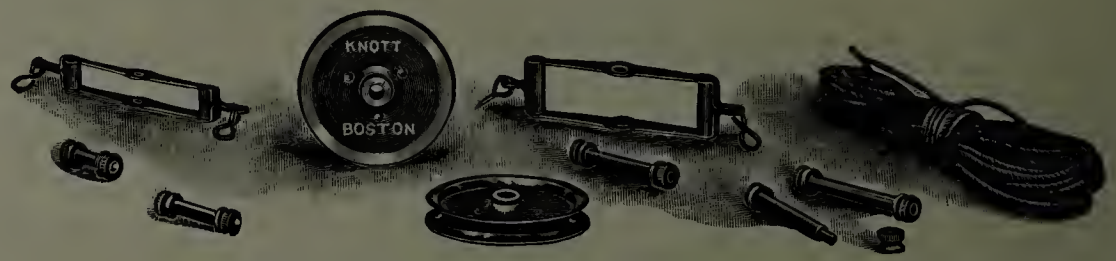
The wheels are made of thin pressed steel, 5 centimeters in diameter. Each pulley is carefully mounted and having less bearing surface than the old style, turns more freely. Designed for use as either fixed or movable pulley.

27–125	**SINGLE PULLEY**	$0.18
27–126	**DOUBLE PULLEY**	.30
27–127	**TRIPLE PULLEY**	.40
27–128	**QUADRUPLE PULLEY**	.55

For **FRICTIONLESS PULLEYS** we recommend the following:

HARCOURT BALL-BEARING FRICTIONLESS PULLEYS

A PULLEY is one of the most essential requisites in the study of Mechanical Powers. The attainment of results where guesswork is not required for the formulation of the laws has been confined largely to a class of instruments not within the reach of the appropriation of many educational institutions. In many of the pulley experiments as conducted in these institutions to-day, the student cannot be blamed for the inaccuracies of his conclusions. Our experience has advised and our experimentation has designed our present **BALL-BEARING FRICTIONLESS PULLEY,** which we can heartily recommend. It has the further quality of **Expansion Possibilities,** in that, with a basis of the single unsheaved pulley and with the addition of an outfit of axles and stirrups, any combination up to two pulleys of five sheaves is possible.



Illustrating Unit Parts to Assemble as Pictured Opposite

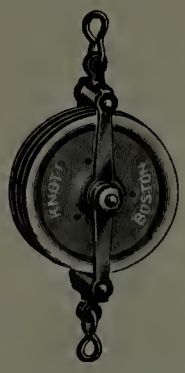
27–165	**BALL-BEARING PULLEY UNIT**	$0.35
27–167	**AXLE ROD,** Single Pulley	.08
27–169	**AXLE ROD,** Double Pulley	.08
27–171	**AXLE ROD,** Triple Pulley	.08
27–173	**AXLE ROD,** Quadruple Pulley	.08
27–175	**AXLE ROD,** Quintuple Pulley	.08
27–177	**STIRRUP,** Single, Triple, or Quintuple	.20
27–179	**STIRRUP,** Double or Quadruple	.20

Our **BALL-BEARING FRICTIONLESS PULLEY** is shown in detail in the above illustration, and various sheaves are pictured on the opposite page.

By inspection of the single pulley without stirrup, the face and edge of which are both shown, it will be noted that this pulley is made up of two parts, each stamped out of one piece of metal by means of expensive tools and dies. Both are then riveted firmly together with ball race in place. In assembling it is only necessary to use the metal stirrup, stamped and formed also by tools and dies, and to attach to pulley by means of the shortest axle illustrated. No tools are required, as all attachment is secured by two thumb nuts. In assembling a sheave of two or four pulleys, the wider stirrup is needed, using the correct length axle rod. In assembling a sheave of five pulleys, the narrow stirrup is used with the longest axle rod.

Each pulley with all parts is neatly nickeled and stirrup is provided with double hooks. For convenience in purchasing, we list assembled sheaves. When experimenting with these pulleys, we desire to urge upon our patrons the necessity of using a cord of about 1/16 inch diameter.

No. 27–150



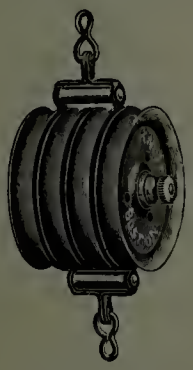
No. 27–152

No. 27–154

27–150 **SINGLE BALL-BEARING PULLEY,** comprises one No. **27–165,** one No. **27–167,** one No. **27–177** . . **$0.60**

27–152 **DOUBLE BALL-BEARING PULLEY,** comprises two No. **27–165,** one No. **27–169,** one No. **27–179** . **.95**

27–154 **TRIPLE BALL-BEARING PULLEY,** comprises three No. **27–165,** one No. **27–171,** one No. **27–177** . **1.30**



No. 27–156

No. 27–158

27–156 **QUADRUPLE BALL-BEARING PULLEY,** comprises four No. **27–165,** one No. **27–173,** one No. **27–179** **$1.65**

27–158 **QUINTUPLE BALL-BEARING PULLEY,** comprises five No. **27–165,** one No. **27–175,** one No. **27–177** **2.00**

HARCOURT STEEL BALL-BEARING PULLEY ASSORTMENTS

All of the following sets are made up of the well-known Harcourt Ball-Bearing Pulleys fully illustrated and described above. Each set includes pulleys, stirrups, and axle rods sufficient for assembling any of the combinations as listed.

27–140 **SIMPLE PULLEY ASSORTMENT,** parts sufficient to assemble, — 4 Single Pulleys or 2 Double Pulleys . . . . . Per Set **$3.00**

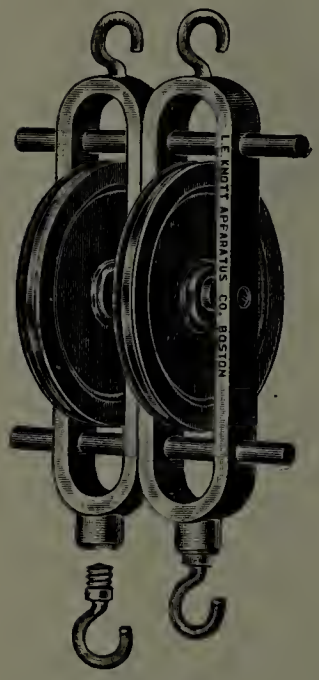
27–141 **PULLEY ASSORTMENT,** parts sufficient to assemble, — 6 Single Pulleys or 3 Double Pulleys or 2 Triple Pulleys . . . . . .Per Set **4.70**

27–142 **PULLEY ASSORTMENT,** parts sufficient to assemble, — 8 Single Pulleys or 4 Double Pulleys or 2 Triple Pulleys or 2 Quadruple Pulleys . . . . . .Per Set **6.40**

27–143 **PULLEY ASSORTMENT,** parts sufficient to assemble, — 12 Single Pulleys or 6 Double Pulleys or 4 Triple Pulleys or 3 Quadruple Pulleys or 2 Quintuple Pulleys . . . . . .Per Set **9.60**

The above assortment, No. **27–143,** will be found adequate for study of the principal combinations of pulleys in deriving mechanical advantages of the same. It is, therefore, highly recommended as a lecture-table demonstration assortment.

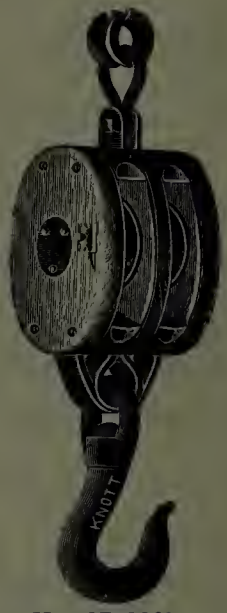
27–185 **PULLEY CORD,** especially adapted for all pulley experiments. This cord is of extra quality hemp, 1/16 inch diameter . . . . . .Per hank of 5 yards **$0 20**



No. 27–200

No. 27–216

No. 27–230a



No. 27–230b

No. 27–230c

27–200 **LATHE TURNED PULLEY,** a frictionless running, brass pulley, 2½ inches in diameter, mounted in heavy brass frame on hardened steel cone bearings. Each pulley is carefully turned, centered in a lathe, and, therefore, when mounted runs absolutely true and is in true balance. The rim is turned with square groove that accurate measurement of diameter may readily be secured. Both ends of the frame are provided with hooks one of which may be removed from the frame and replaced by any rod tapped ¼ × 20 (See No. **5–10**). Different combinations as illustrated are possible by use of a pair of steel rods.
All parts handsomely nickel-plated . . . . . Each Pulley **$2.45**

27–201 **STEEL RODS** for use in making combinations of above Lathe Turned Pulley . . . . . Per Pair **.20**

27–216 **TRIPLE TANDEM PULLEY** for comparison of the mechanical advantages of pulley arrangement. Each tandem pulley consists of three pulley wheels of different diameters mounted in cone bearings in a metal frame. Each pulley is lathe turned, carefully mounted and adjusted . . . Each **1.05**

No. 5–950

No. 5–952

5–950 **PULLEY ON ROD,** axis at right angles to rod **$0.94**

5–952 **PULLEY ON ROD,** axis in same plane as rod . . . . . **.90**

TACKLE BLOCKS (HARCOURT PATENT). These commercial pulleys must not be confused with inexpensive types. They are carefully made from lignum-vitæ with self-lubricating iron bushings. Each shell is provided with a swivel hook and becket.

27–230 **TACKLE BLOCKS,** size of sheave 2¼ × ⅝ × ⅜ inches; length of shell, 4 inches; requires rope ½ inch diameter.

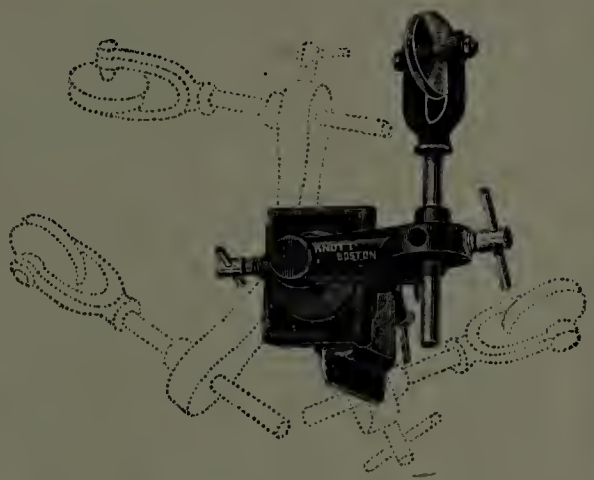
	a	b	c
	Single	Double	Triple
Each	**$1.70**	**$2.10**	**$2.85**

We are prepared to furnish the commercial blocks of cheaper construction. For science laboratory use, however, we recommend the superior quality as listed above.

27–235 **MANILA CORDAGE,** ½ inch diameter, as required with above Tackle Blocks. This rope is constructed of only the best quality of manila hemp. Sold only in multiples of 10 feet. Per 10 Feet **$0.25**

No. 27–240

No. 27–250 (Front View)



No. 27–250 (Top View)

No. 27–242

27–240 DIFFERENTIAL PULLEY HOIST, for illustration of and determination of mechanical advantage of a commercial differential pulley hoist.

This hoist is carefully made and thoroughly tested to the capacity of ¼ ton before shipping. Only the best of hand-made chain is used, and careful attention to all details makes this a safe instrument under full capacity and of an accuracy which would be classed under Scientific Apparatus. Regular hoist, 6 feet; minimum distance between hooks, 17 inches; weight, 22 pounds; capacity, ¼ ton; chain pull, 72 pounds through 18 feet **$11.75**

27–242 DIFFERENTIAL PULLEY HOIST, smaller model with brass pulleys, mounted on stand **7.50**

27–250 T-BEAM UNIVERSAL PULLEY. This pulley is one of our Harcourt Universal T-Beam Series, and we justly claim for it advantages that can only be realized when once used. The table clamp is our No. **5–1000** Basic Clamp "A." Attached adjustably to the beveled slide of this clamp is our Universal Pulley Interlocking Attachment No. **5–1080.** This attachment consists of two castings, the interlocking base provided with a nickel-plated T-screw for fixing to the beveled slide top of the basic clamp, and a pulley arm which swivels about the post of the interlocking base. As may be noted, this arm may be firmly locked by the T-screw in the post. At the end of the pulley arm, cast as a part of the arm, is a circular block in which are drilled a number of holes, in any of which the pulley rod may be locked by a T-screw.

The pulley itself is of careful construction and is mounted on cone bearings in a stirrup which is attached to the rod.

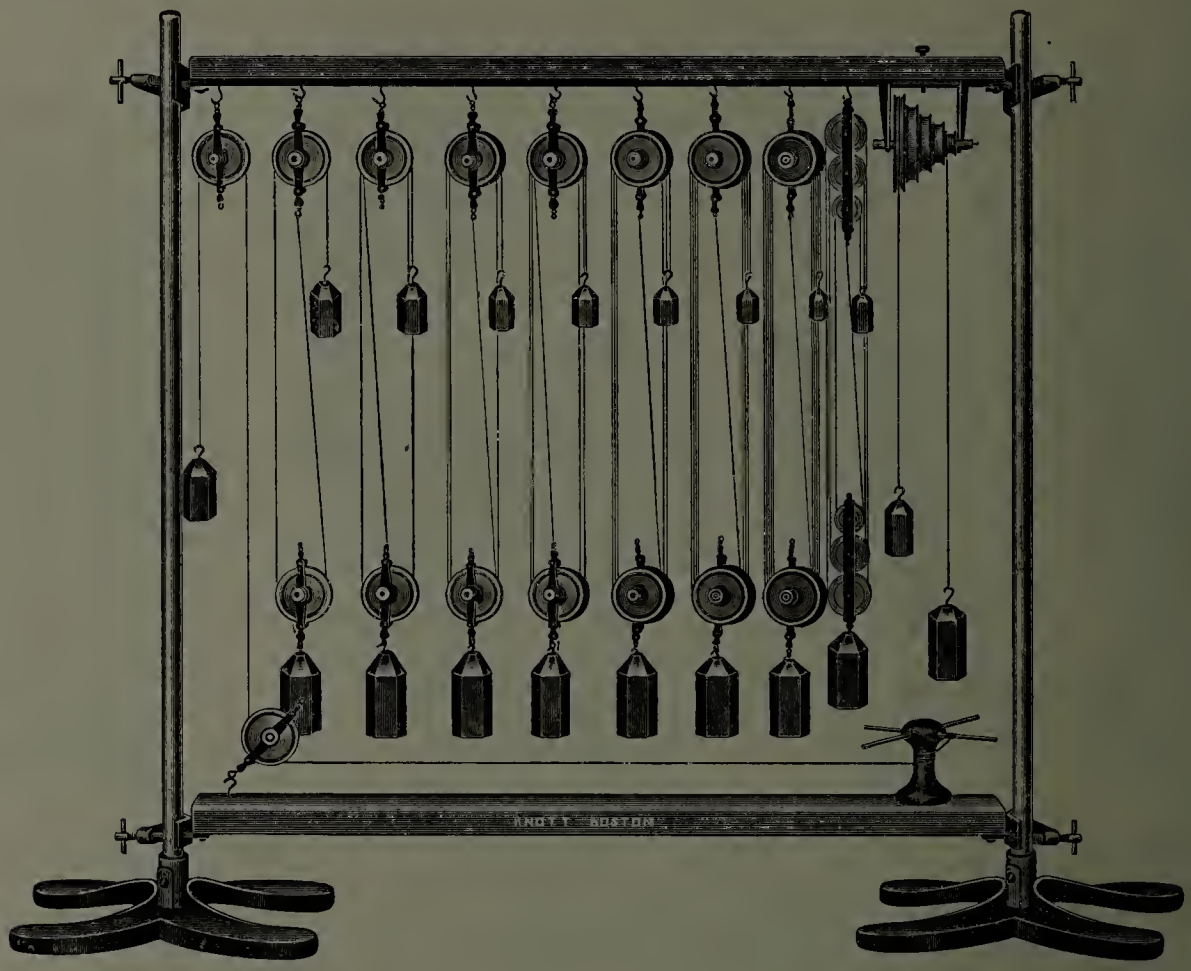
We claim for our design a possibility of adjustments never heretofore attained by any design; in addition, a greater ease and rapidity in securing multitudinous positions. We also secure a backward and forward movement along the beveled slide. All positions may be firmly locked by the nickel-plated T-screws.

T-beam Universal Pulley, complete as illustrated **2.65**

Persons equipped with Universal T-beam Basic Clamp "A" need purchase only Interlocking Attachment.

5–1000 HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "A" . . $0.94

5–1080 UNIVERSAL PULLEY INTERLOCKING ATTACHMENT . . . 1.75



No. 27–275

27–275 PULLEY DEMONSTRATION APPARATUS. The frequent call for a complete outfit for demonstration of pulleys and the application of the principles thereof to wheels and axles and capstans has led us to design and assemble the above illustrated combination.

As may be noted, the instrument consists of two upright rods mounted on our new form H-base connecting these upright rods on two cross-bars provided with special clamps for attachment to the rods. To these cross-bars are attached the various combinations which can be assembled from the outfit listed below.

The apparatus as above illustrated is furnished complete with all accessories as follows, —

A Complete Equipment of Pulleys for Illustrating:

Fixed pulley, weight and power equal.

Fixed and movable pulleys for securing the following combinations: weight and power as 1:2; 1:3; 1:4; 1:5; 1:6; 1:8; and 1:10.

These pulleys are the Harcourt Steel Ball-Bearing Pulleys (see page 111), an outfit being supplied capable of giving any of the combinations above desired; thus one may secure quintuple, quadruple, triple, double, and single pulleys in various combinations.

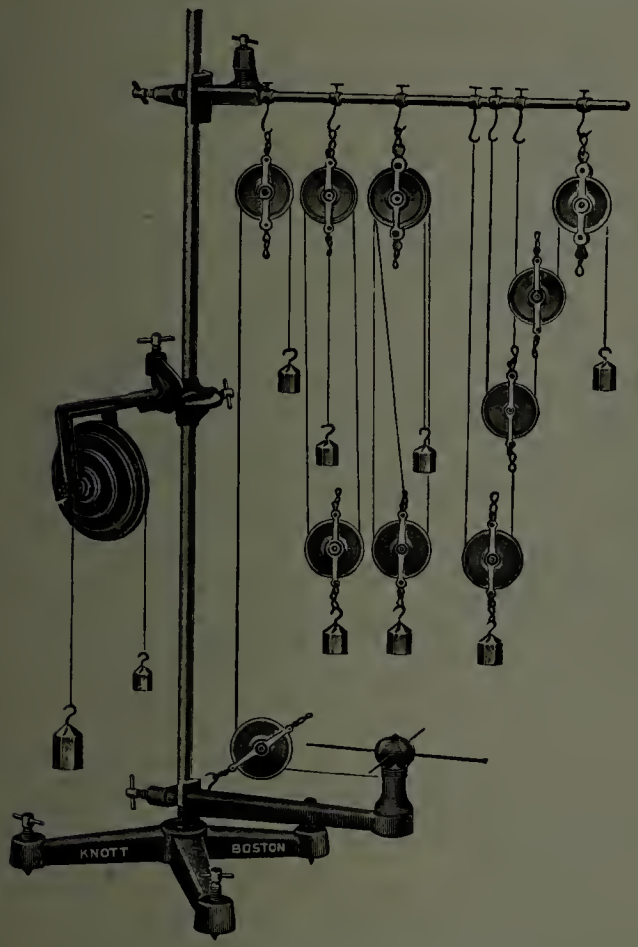
Improved Wheel and Axle, 5 diameters which are based upon simple weight ratios.

Capstan and Lever. 1 pair triple tandem pulleys.

The equipment which we furnish consists of the frame itself, the Wheel and Axle, the Capstan and Lever, a pair of Triple Tandem Pulleys and in addition, a sufficient number of the Harcourt Ball-bearing Pulley Units, Axles and Stirrups to set up the various pulley combinations shown above.

Apparatus complete as described without weights **$20.00**

PULLEY STUDY APPARATUS



PULLEY STUDY APPARATUS

The only distinctive item required for "set up" illustrated is as follows:

27–290 CAPSTAN ARM with CAPSTAN. This is a special casting with clamp and arm in one piece. At the end is mounted a capstan $1.90

Other apparatus illustrated, elsewhere listed.

5–770	RIGHT ANGLE CLAMP	.95
22–131	BASE AND ROD	3.15
5–645	HOOK COLLARS (4 needed) . . Each	.24
27–150	BALL-BEARING SINGLE PULLEYS (4 needed)	.60
27–152	BALL-BEARING DOUBLE PULLEY . .	.95
27–325	WHEEL AND AXLE	1.75
5–10d	SUPPORT ROD	.25

NOTE. — Our No. **22–130** Tripod Support without levelling screws may be used if desired in the place of the one illustrated.

No. 27–335

25–251 CULLER'S ADJUSTABLE LEVER, PULLEY AND PENDULUM CLASP AND HOOK ROD after Dr. J. A. Culler, Miami University, Oxford, Ohio. The title of this ingenious device is descriptive of its manifold uses. (See Experiments VII, X and XI of Culler's "Laboratory Manual of Physics.") Clasp and Hook Rod only $1.60

25–251a ——, with Clamp $2.40

27–305 WOODEN STRIP with **TWO HOOKS** after Turner and Hersey, Exp. **M320** .20

27–325 ALUMINUM FIVE DIAMETER WHEEL AND AXLE, for attachment to support rod by means of a clamp, in determining the Mechanical Advantage of a Wheel and Axle.

No. 27–325

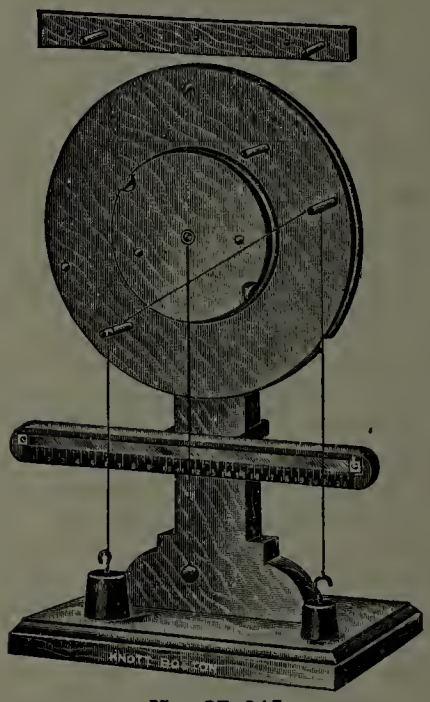
This Wheel and Axle is made from new specifications which have been figured on the basis of simple ratios. It is made of aluminum, nicely finished, with 5 diameters. It is mounted in cone pivots in a metal frame attached to a ½ inch rod for use in clamp.

Without Clamp 1.75

The Clamp illustrated is No. **5–770 RIGHT ANGLE CLAMP** 95

27–335 WHEEL AND AXLE, after Hall and Bergen's "A Text-Book of Physics," paragraph 64, for determining the Mechanical Advantage of Wheel and Axle; also provided with attachments showing that the Wheel and Axle is simply a modified lever of the First Class.

This apparatus consists of two wooden discs combined in one piece attached at its center to a wooden rod by means of a screw, about which it is free to move as an axle. This wooden rod is devised for clamping to the cross beam of the Standard Physics Table or other convenient means of support. At various points on the disc are drilled holes to which cords may be attached by use of brass pins thrust into them 95



No. 27–345

No. 27–360

27–345 HORTVET'S APPARATUS, illustrating that the Mechanical Advantage of the Wheel and Axle is the same as that of the Lever of the first class; also for demonstrating principles of both machines which are not possible with the simplified apparatus.

This apparatus consists of an upright wooden stand, vertically supported on which is a disc of wood having 2 diameters. At various convenient points on this disc are drilled holes into which brass pins may be thrust for support of cords which, suspended from these pins, answer the double purpose of attaching weights and of supplying a plumb line for measuring the diameters of the two discs or of lengths of the "Power" and "Weight" Arms, the readings being taken from the plumb line dropped from the center axle. Just below the disc, attached at right angles to the upright, is a cross head which bears a scale and a narrow mirror which obviates, in reading, errors due to parallax.

Experimental work on Levers, with fulcrum below or above line of support of "Power" and "Weight," is one of the features of this instrument not possible on instruments of simple form. Many other interesting problems are possible with this apparatus.

Apparatus complete as illustrated with the addition of a simple Lever which may be attached in place of the disc on the upright **$7.25**

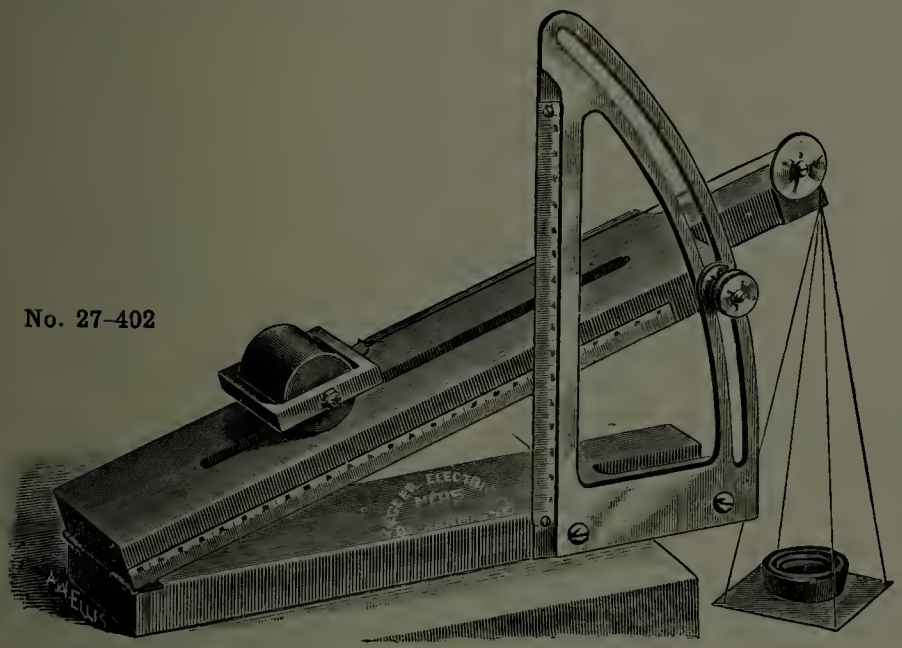
27–360 GAGE'S MECHANICAL POWERS APPARATUS for determining Mechanical Advantage of simple machines such as the Lever of the first, second, or third class, the Wheel and Axle, and the Pulley.

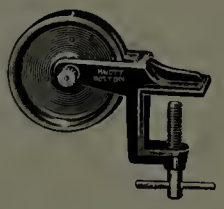
The apparatus consists of a well-balanced lever arm provided with a brass central piece with holes through which may be thrust the fulcrum pin on which lever may be supported on the forked support in demonstrating an equal arm lever of the first class. A second hole provided in this brass piece serves to illustrate the effect of raising or lowering the center of oscillation. The illustration shows method of securing levers of the second and third classes, the second class being the one illustrated.

The forked stand is also for use as a support for the wheel and axle (two being illustrated above, but one only being furnished). The weight is supplied by means of special forms of double-hooked brass weights, ten of which are furnished with each outfit.

Apparatus complete as illustrated, including one forked stand, one lever bar, one wheel and axle, support rod and round base, one clamp and arm, one ball-bearing single pulley, one stirrup, a scale pan, and ten double-hooked weights **7.65**

No. 27-402





No. 27-393

27-390 **HALL'S IMPROVED INCLINED PLANE WITH SIDE RAILS AND SCREW ADJUSTMENT.** This plane is a neatly finished close-grained wooden plank provided with side ledges. It is 120 centimeters long and 15 centimeters wide. It is furnished with screw adjustment for comparison of masses by the acceleration test. (See Hall & Bergen's "A Text-Book of Physics," Exercise **36**) **$1.60**

27-392 **MAHOGANY FINISHED POLISHED INCLINED PLANE,** after Millikan, Gale and Bishop, "Laboratory Physics" (Experiment **17**). This plane is a smooth hardwood surface, 5 inches wide, 4 feet long . . . . . **.75**

27-393 **PULLEY IN FRAME,** as used in above, for attachment to any board . . . . . **.75**

27-394 **SONOMETER ATTACHMENT** for Inclined Plane No. **27-392** . . . . . **.20**

27-400 **HALL'S INCLINED PLANE APPARATUS** for determining the mechanical advantage of the inclined plane.

This apparatus consists of a wooden base to which is hinged a board, the surface of which is carefully smoothed and finished. This board may be inclined at any desired angle as indicated by the graduated metal arc, and set to same by means of a knurled head. "Power" and "weight" are balanced over a freely running pulley set in pivotal bearings. Graduated scales for both incline and height.

Plane only, without illustrated scale pan, roller, and weights **4.45**

27-402 ——, same as above but is provided with a roller as above illustrated, adjusted to weigh exactly one pound. It is also furnished with the scale pan but without weights **6.60**

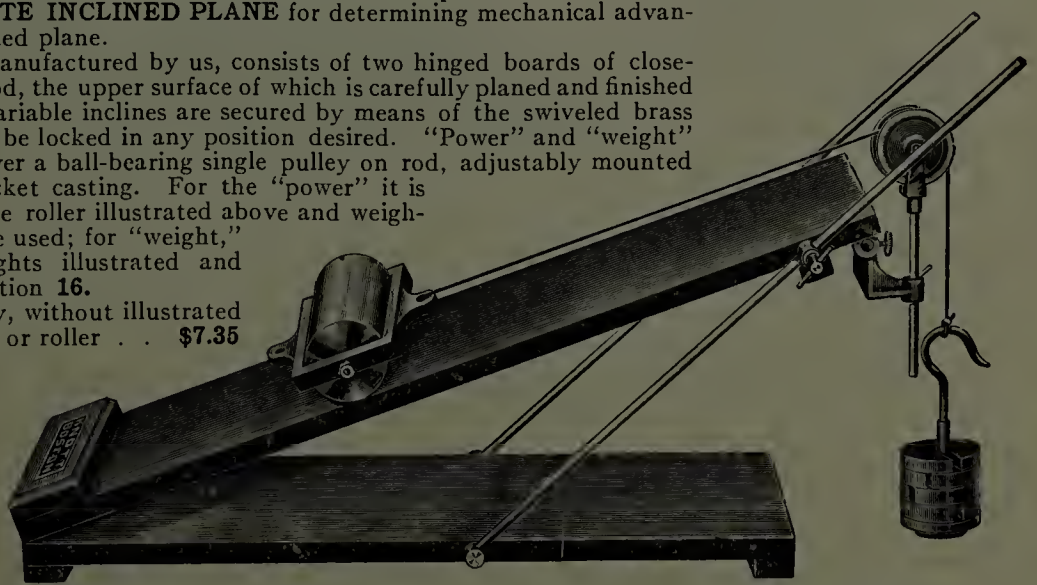
27-405 **ROLLER FOR INCLINED PLANE** for use as the "Weight" in determining the Mechanical Advantage of the Inclined Plane.

Consists of a carefully turned roller, ends centered and pivoted in metal frame **1.95**

27-410 **PRATT INSTITUTE INCLINED PLANE** for determining mechanical advantage of an inclined plane.

This apparatus, manufactured by us, consists of two hinged boards of close-grained hardwood, the upper surface of which is carefully planed and finished smooth. The variable inclines are secured by means of the swiveled brass rods which may be locked in any position desired. "Power" and "weight" are balanced over a ball-bearing single pulley on rod, adjustably mounted in a special bracket casting. For the "power" it is designed that the roller illustrated above and weighing 11 pounds be used; for "weight," hanger and weights illustrated and described in Section **16.**

Inclined Plane only, without illustrated weights, hanger, or roller . . **$7.35**

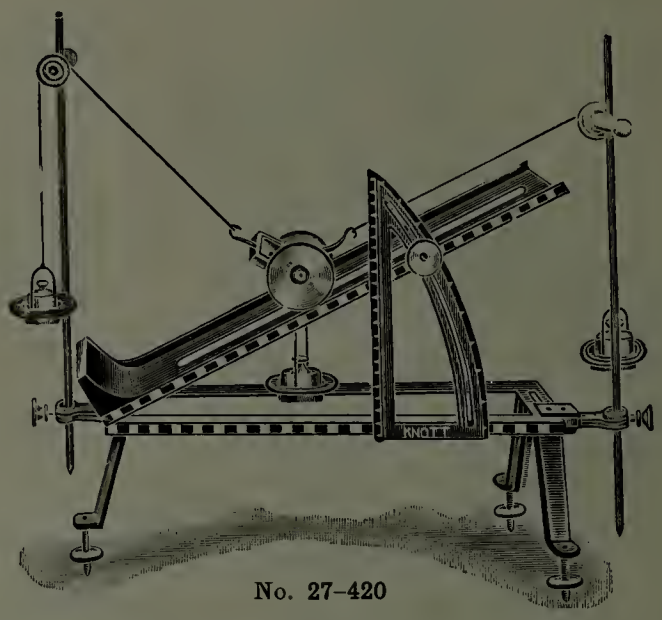


No. 27-410

27-412 **PRATT INSTITUTE INCLINED PLANE ROLLER.** This roller as above described weighs 11 pounds. The surface is carefully turned and is mounted in a frame in pivotal bearings. Although designed especially for use with the above inclined plane it may be used to advantage on any incline whatsoever.

Roller only, as above illustrated **$3.15**

WEIGHTS. Section **16.**



No. 27–420

27–420 WEINHOLD'S DEMONSTRATION INCLINED PLANE for the quantitative study of factors governing mechanical advantage of an inclined plane.

In this apparatus, with graduated arc, length, height, and incline dimensions, not only may the Mechanical Advantage of an Incline be quantitatively determined, but also the normal pressure on the plane can be measured.

The apparatus consists of a frame, as illustrated, similar in appearance to any carefully constructed Inclined Plane. The roll, however, of this plane is provided with three stirrups for use as illustrated in measuring normal pressure on the plane, one component being determined by a mass hung over a pulley attached to the upright rod at the right, the other component, by the mass hung similarly at the left.

This plane is carefully constructed throughout, all parts being neatly finished.

Furnished complete as illustrated, but without weights of any kind . . . . . Duty Free **$28.45**

No. 27–435

27–435 INCLINED PLANE CAR for use with weights as the "Weight" in determining the Mechanical Advantage of the Inclined Plane.

In this car we have attempted to obviate the errors of the ordinary four-wheel type, and use a car with three wheels only, thus securing positive wheel action on all three wheels.

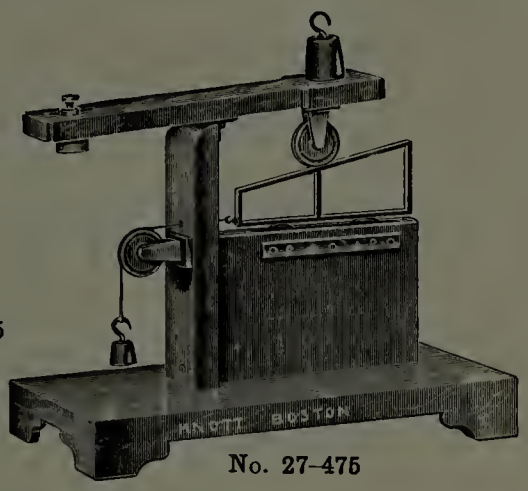
The body of this car is a metal casting, neatly finished in japan; the wheels, mounted in frictionless cone bearings, are lacquered brass. A hook for attaching the power is also provided **$1.55**

27–440 INCLINED PLANE CAR, type with four wheels in pivotal bearings **1.10**

27–450 WOODEN SPREADER for experiments with an Inclined Plane when it is desired to use "Power" parallel to base.

When there is no slot lengthwise of the incline, this spreader will be found a great convenience . . **.10**

27–465 RUBBER CORD for use in experiments with an Inclined Plane Car on Inclined Plane in Inertia Experiments, as described in Hall & Bergen's "A Text-Book of Physics," Exercise **36** . . Each **.20**

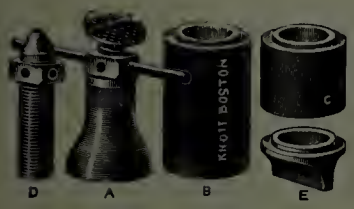


No. 27–475

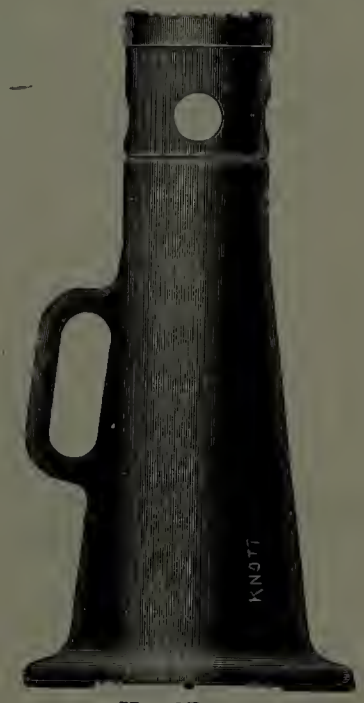
27–475 MODEL OF WEDGE for determining the Mechanical Advantage of a Wedge.
This apparatus consists of a wedge-shaped metal skeleton which in operation is held between three easily running pulley wheels supported above and below the wedge. "Power" is attached by means of a cord over the fourth pulley illustrated. "Weight" is supported from above on hinged platform.
Complete without weights $8.25
WEIGHTS. See Section **16**.

27–485 WEDGE, consisting of a two-part piece of hard wood, 18 centimeters long, each part 2½ centimeters at point of greatest thickness . . . . . Each **$0.80**

No. 27–500



No. 27–510



No. 27–520

27–500 MODEL OF A SCREW for the qualitative illustration of the great force of a screw. The design above pictured illustrates the tremendous power that may be secured by means of a screw.
This design consists of a modification of one of our T-Beam designs, the modification consisting of a special casting attachment with breaking wedges securely fastened to the face of our Basic Clamp "B" **$1.65**

27–510 JACK SCREW, demonstrating the Mechanical Advantage of the Screw; also used for leveling up purposes.
This Jack Screw is 1¼ inches in diameter at the base and has a range from 2¼ to 3⅝ inches. By use of extension bases B and C, a range of from 2¼ to 6½ inches is possible. An auxiliary pointed screw D is supplied which may be used in place of the screw with swivel cap when desired. The base E is also provided for use in special cases.
Jack Screw complete as illustrated, including A, B, C, D, and E **1.85**

27–510A JACK, only **1.00**

27–510B EXTENSION BASE, 2 inches high . . . . . **.30**

27–510C EXTENSION BASE, 1 inch high . . . . . **.20**

27–510D EXTENSION SCREW . . . . . **.20**

27–510E EXTENSION BASE . . . . . **.20**

27–520 FIVE-TON ROLLER-BEARING JACK SCREW. These Jack Screws are of cast iron with a 1 3/16 inch steel screw with square threads and provided with roller bearings. Total height when screw is closed is approximately 8 inches; lifting capacity five tons **4.30**

MODELS OF COMPLEX MACHINES

28–10 SIMPLE GEARED WHEELS, illustrating the great mechanical advantage of a system of geared wheels.

This system consists of two wheels with pinions one-fourth the diameter of the wheels, while a third wheel has a drum of the same ratio, thus giving a mechanical advantage of 1 to 64. Gears mounted on rod for clamping to a support. Apparatus as illustrated shows use of our No. **5–770** Right Angle Clamp mounted on the rod of our No. **22–130** Universal Support.

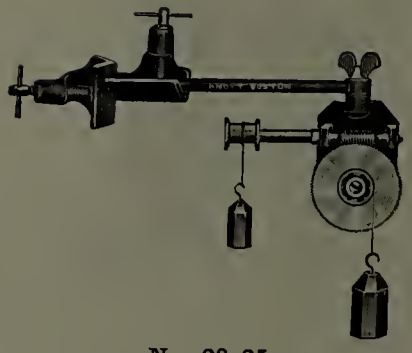
Geared wheels only, without illustrated clamp **$3.85**
The clamp illustrated is **5–770 Right Angle Clamp** . . . . . **.95**

28–25 ENDLESS SCREW for determining the mechanical advantage of a gear operated by a screw.

This apparatus consists of a disc gear with drum for holding weight. This gear is actuated by an endless screw, one end of which terminates in a drum around which is attached the "power." The whole is mounted to a casting which is attached to a rod by a swivel joint which may be held fixed by a thumb nut. This rod may be clamped to any support by use of any right angle clamp, our No. **5–770** Clamp being illustrated.

Endless screw only, without illustrated clamp **5.45**
The clamp illustrated is **5–770 Right Angle Clamp** . . . . . **.95**

No. 28–10



No. 28–25

No. 28–75

28–75 CRANE DEMONSTRATION APPARATUS for quantitative demonstrations of boom stress and guy strains in cranes.

This apparatus consists of a boom devised to register all stresses in pounds or grams up to 30 pounds or 16 kilograms. It is shown illustrated with apparatus previously listed which, if already a part of the school equipment, need not be added.

Crane Boom only, with attached chains **$6.60**

28–78 THREADED HOOK, threaded ¼ × 20, for use with No. **5–785** Right Angle Clamp as illustrated **.15**

15–332 SPRING DYNAMOMETER, registering 20 pounds **2.15**

Other apparatus above illustrated but previously listed is as follows:

5–1150 HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "B" **1.65**
5–730 RIGHT ANGLE CLAMP . . . . . **.65**
5–785 RIGHT ANGLE CLAMP . . . . . **.45**
5–20e SUPPORT ROD, 19 millimeters diameter, 100 centimeters long **1.00**

28–79 CRANE BOOM after Fuller and Brownlee (Experiment **24**) . . . . . **.25**

PRATT INSTITUTE APPLIED PHYSICS APPARATUS

On the following pages is illustrated a line of apparatus as new to the scientific instrument houses as it is to educational laboratories in America. This line follows the designs as used in Pratt Institute, which have been worked out to meet the definite need of such work as is done at this institution.

The illustrations showing the line we are now offering were made from the pieces built for Wentworth Institute, Boston, under the immediate supervision of Professor W. H. Timbie, Director of the Applied Physics Department.

Technical Schools, Trade Schools, Manual Training Schools, and High Schools giving vocational or manual training courses, will be interested in these pages.

DISTINCTIVE FEATURES. While some of the pieces in form, at least, will suggest the older types common in laboratory work, it must be noted that there is an essential difference, viz., *size.* All the parts are made *large* for a definite, pedagogical reason, the educational value of muscular reaction serving as the keynote of this work in Applied Mechanics.

The large crane, for example, will illustrate our point. This stands over seven feet high and is capable of handling a load of over 200 lbs. It at once impresses the student with its commercial importance and hence worthy of his serious attention. The design is such that notwithstanding that the commercial form has been maintained every strain and reaction may be definitely determined and correct functions deduced.

No. 27–410

27–410 INCLINED PLANE. This instrument, when used in connection with the 11-lb. roller as illustrated, is well worked out for the study of,—

1st, Forces supporting a body on a frictionless surface.

2d, When used in connection with the Pratt Institute car, catalogue No. **27–435,** a study of the forces parallel to the incline may be made.

3d, When used with a friction block, catalogue No. **27–12,** the determination of the coefficient of friction by the two more common methods is readily made.

By the use of this plane all of the above problems may be solved in a more effective way, than with the plane usually furnished.

Inclined Plane as listed, without weights, hanger, and roller **$7.35**

27–412 ROLLER, accurately centered and finished, weight 11 lbs **3.15**

27–435 PRATT INSTITUTE CAR of accurate construction and correct design **1.55**

HANGERS AND WEIGHTS. Section **16.**

No. 29-30

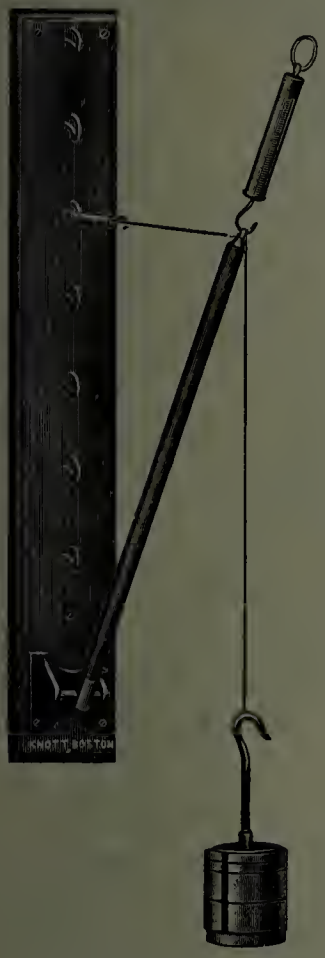
29-30 SHEAR LEGS. A most impressive illustration of the composition of forces as applied to the shear legs, solving definitely the following:

1st. The tension in the tie.
2d. The compression in the legs of shears.
3d. The forces necessary to keep the legs from spreading.

Made of seamless tubing, correct design of hinge so that every force is exerted at its proper point.
Price complete, without balances, weights, or hanger **$5.40**

15-334 SPRING DYNAMOMETER, registering 60 pounds **3.20**

HANGERS AND WEIGHTS. Section **16.**



No. 29–60

29–60 SIMPLE TRUSS. This simple apparatus serves to teach in the most direct manner possible, forces in the **Simple Stick and Tie.** The angle of inclination and load may be varied at will and the component forces at each angle accurately determined. When the angle of the Truss is increased to 90 degrees, the problem is even more interesting to the student.

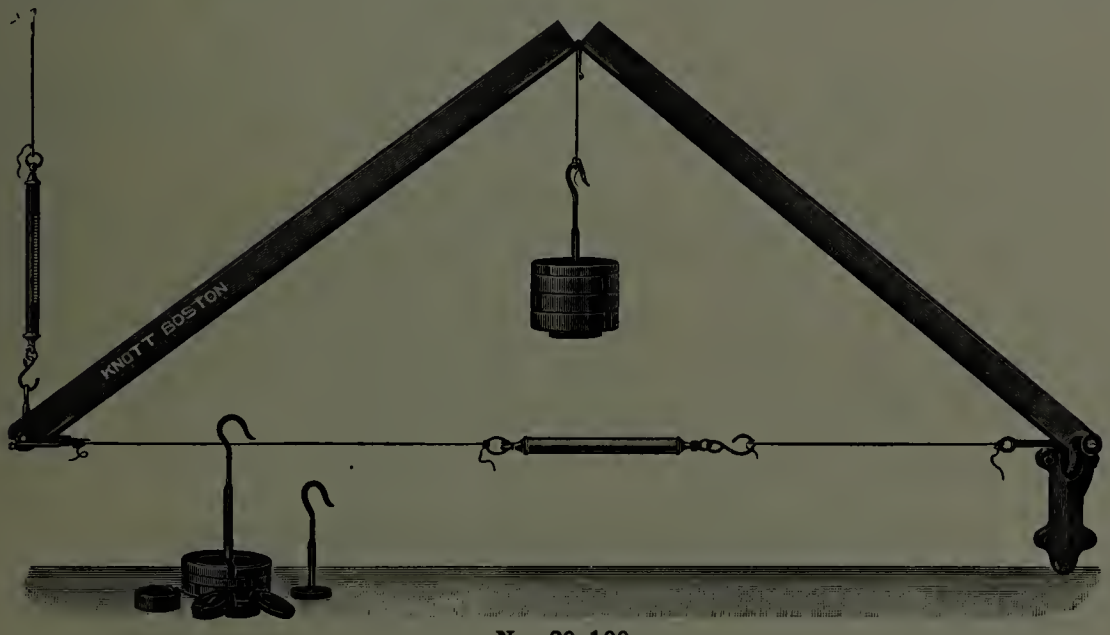
Price, without Balances and Weights **$2.85**

29–80 SMALL HOISTING CRANE. A substantial, but simply designed apparatus for determining both the tension and compression in the **Hoisting Crane.** In this exercise the weight of the boom, which is material, should be taken into consideration.

Price, without Balances and Weights **3.85**

15–332 SPRING DYNAMOMETER, registering 20 pounds **2.15**

No. 29–80



No. 29–100

29–100 ROOF TRUSS. The laws of Equilibrium, as manifest in the simple Roof Truss, are strikingly solved with the above apparatus. Note that the pressure at every point is definitely measured. The support for holding the Truss against the side of the wall is so designed that the Truss may be loaded with a block of iron of uniform size, resembling pressure or strains made by the **snow load** or the **wind pressure load** on the roof.

Price of parts complete as illustrated, without Balance, Weights and Hangers **$4.25**

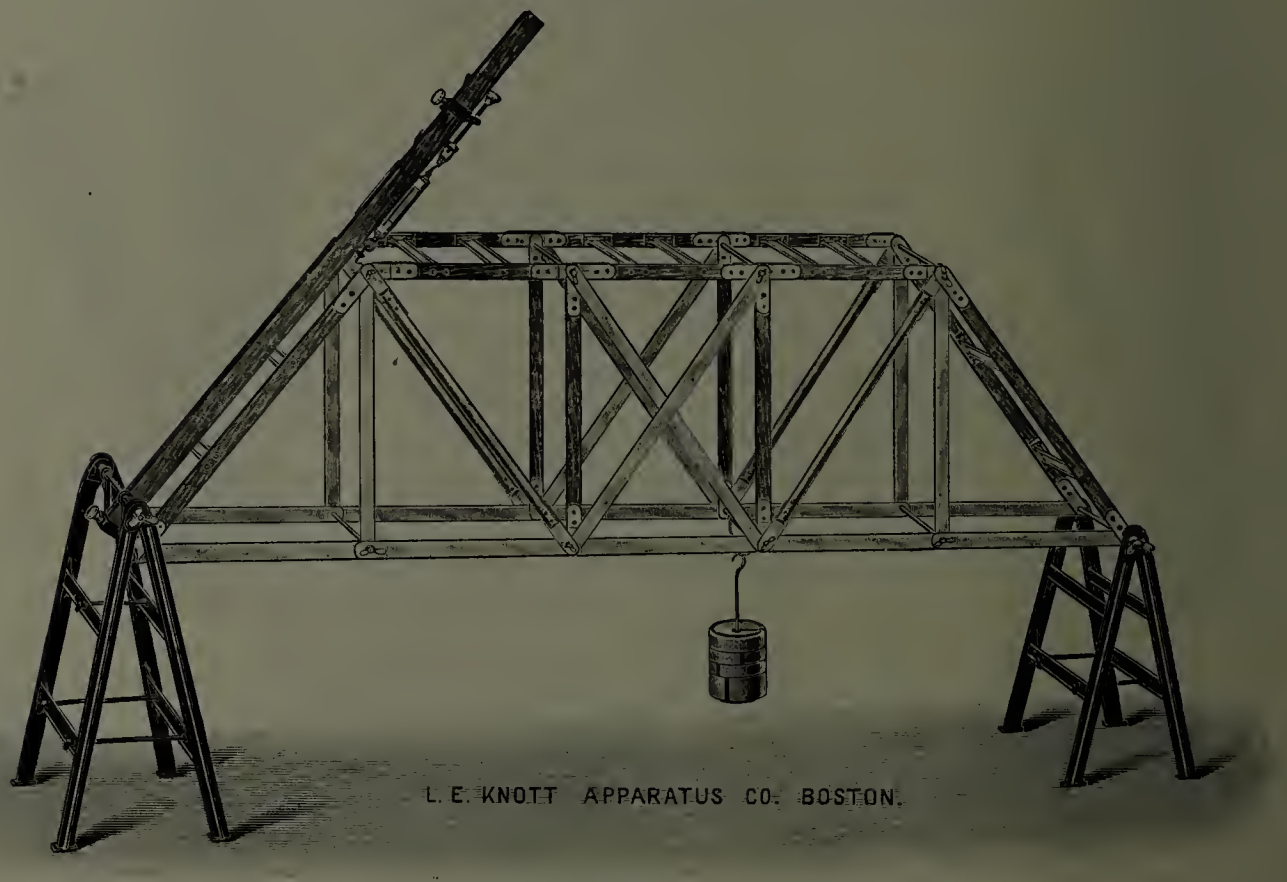
15–334 SPRING DYNAMOMETER, registering 60 pounds **3.20**

HANGERS AND WEIGHTS. Section **16.**

DAVIS' MODEL BRIDGE

DESIGNED BY

Prof. HARVEY N. DAVIS, Harvard University, Cambridge, Mass.



No. 29-110

29–110 **DAVIS' MODEL BRIDGE** for the study of reactions in a bridge truss. As all members are interchangeable, this model will serve to set up and demonstrate the reactions in a Simple Truss, a Four-Panel Pratt Truss, a Five-Panel Pratt Truss, a King Post Truss, Underslung King Post Truss, a Cantilever Truss, etc.

This apparatus is composed of members of aluminum and mahogany strips and tubes of aluminum. The model as illustrated is 7 feet long, 25 inches high, supported on piers designed for convenient use. The test member is of solid mahogany, provided with special cast bronze attachments for clamping to the pins and holding the dynamometers when measuring tensions or compressions of any of the members.

Complete as illustrated, with piers, tension and compression members, test member, and with special attachment for holding the weight hanger, but without weight hanger, weights or dynamometer **$38.00**

Upon request we will send free a pamphlet containing a series of laboratory experiments and exercises carefully prepared by Professors Davis and Black. Additional copies for students' use furnished at a nominal price.

WEIGHTS and **WEIGHT HANGERS.** See Section **16.**
DYNAMOMETERS. See Section **15.**

LARGE HOISTING CRANE OR DERRICK

(For illustration, see following page)

29–125 **LARGE HOISTING CRANE OR DERRICK.** The cut will show at a glance the method of determining the various forces, such as:

1st. The tension in the tie.
2d. The vertical and horizontal forces exerted by a boom against the mast.
3d. The amount and direction of the total force of the boom against the mast.
4th The tension in each guy rope.
5th The vertical and horizontal floor reactions at the foot of the mast.
6th. The horizontal component of the forces in the guy ropes. Compare this with the horizontal reaction at the foot of the mast.

Complete without Platform Scale, Balances, and Weights **$18.75**

29–130 **PLATFORM SCALE,** as illustrated opposite **18.75**

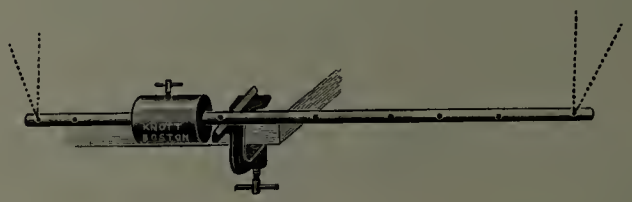
15–334 **SPRING DYNAMOMETER,** registering 60 pounds **3.20**

HANGERS AND WEIGHTS. Section **16.**

LARGE HOISTING CRANE OR DERRICK

No. 29–125

See description on preceding page



No. 29–135

No. 29–145

29–135 FORCES IN A UNIFORM METAL BAR 3 FEET LONG WITH SLIDING LOAD. With this apparatus the forces acting on a body supported by two cords not parallel, also by two cords parallel, may be definitely worked out. Without knife-edge clamp **$7.50**

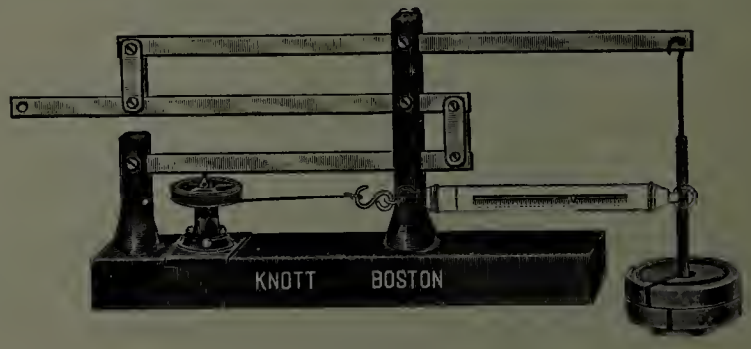
5–596 KNIFE-EDGE CLAMP, as illustrated in above **$0.55**

29–145 STEELYARD OF LARGE LABORATORY FORM. The apparatus is made from a uniform bar with measurable counterpoises and sliding weights. The apparatus is designed to be calibrated by the student according to the principles evolved in determining the center of mass in Uniform Bar Experiments. Without weights and hanger and without support **9.50**

22–130 UNIVERSAL STAND, suggested as a support for above outfit **2.10**

5–15a CROSS BAR SUPPORTING ROD, as illustrated above . . . . . **.25**

5–730 RIGHT ANGLE CLAMP, as illustrated above . . . . . **.65**



No. 29–150

29–150 COMPOUND LEVER AND JACK SCREW. Large in size and substantially built. An apparatus for use on the lecture desk or in the laboratory, in determining the mechanical advantage of the Compound Lever and Jack Screw.

Consists of a substantial base with metal uprights on which are attached the nickel-plated steel members of the Compound Lever. The Jack Screw is of the commercial type, accurately cut screws and substantially built.

Without Weights, Weight Hanger and Dynamometer **$14.75**

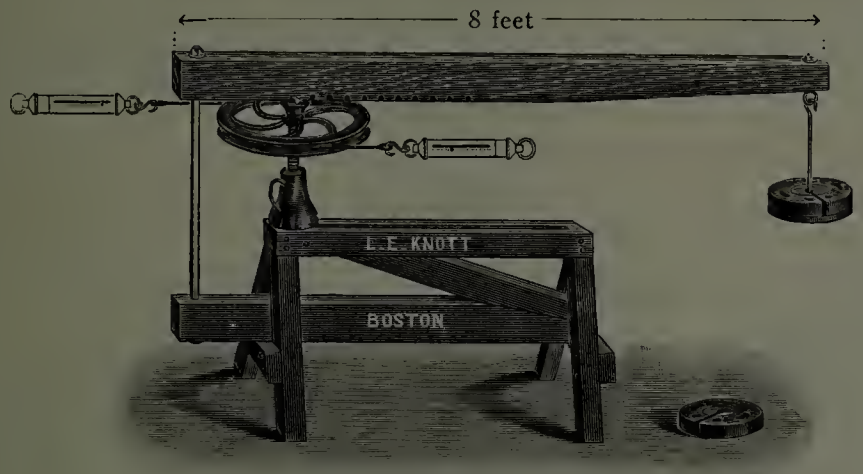
15–332 TWENTY-POUND DYNAMOMETER, 20 pounds by ¼ pound, as illustrated above in outline . **2.15**

WEIGHTS AND WEIGHT HANGERS. See Section **16**.

29–155 WORKING MODEL OF THE ARCH. A four-foot model so designed that all the reactions and thrusts may be definitely determined.

1. The vertical reaction at the abutments.
2. The horizontal reaction at the abutments.
3. The horizontal force at the center of the arch ring.

Complete without Balances and Weights **29.75**



No. 29–165

29-165 **SCREW JACK WITH WHEEL, BASE, AND BAR.** The efficiency test of the commercial screw jack has heretofore been considered out of the realm of laboratory work, even in technical schools. The use of adequate load to represent real conditions has not been feasible except by this method found so successful in Pratt Institute.

With the apparatus the working load may be reckoned in **terms of tons,** while the power is in terms of **hundreds of pounds.**

The apparatus is made up of a supporting base, a self-oiling commercial jack of best quality, a power wheel 18 inches in diameter grooved for cord, a lever arm 8 feet long capable of sustaining the 2-ton load and anchorage bar.

Without weights and dynamometers **$29.50**

29-167 **WEIGHTS** for use with the above, unadjusted, in 50-pound units . . . . . Each **3.75**

29-169 **HANGERS** for weights, unadjusted, approximately 50 pounds . . . . . Each **5.25**

15-334 **SIXTY POUND DYNAMOMETER,** 60 pounds by ½ pound, as illustrated above in outline . . . **3.20**

No. 29–180

29-180 **BENT-ARM LEVER AND SUPPORTING TABLE.** This apparatus has been developed for the purpose of determining the relation between the forces acting on a lever. In its design special attention has been given to the eliminating of all directive forces due to gravity and friction, and enabling the use of forces of large dimensions.

Without Balances **$29.50**

15-332 **TWENTY POUND DYNAMOMETER,** 20 pounds by ¼ pound, as illustrated above in outline . . **2.15**

WEIGHTS AND WEIGHT HANGERS. See Section **16.**

MECHANICS OF LIQUIDS

DENSITY AND SPECIFIC GRAVITY

No. 31–10

Nos. 31–20 to 31–27

No. 31–35

31–10 ARCHIMEDES' PRINCIPLE for demonstrating that a body submerged in water displaces an amount equal to its own volume.
This apparatus consists of a solid cylinder and bucket accurately machined so that the cylinder will exactly fit and fill the bucket. Each is provided with hooks and the bucket is further provided with a handle.
Polished and lacquered **$1.20**

31–18 OVERFLOW CAN AND CATCH BUCKET for formulating Archimedes' Principle. This apparatus consists of a nickel-plated spring brass Can with overflow spout near the top. The Catch Bucket, also of nickel-plated spring brass, is provided with a handle and is of convenient height for placing under overflow spout. In use, the Catch Bucket is placed under the mouth of the spout and the Overflow Can filled until water begins to flow. When flow has ceased, the water in the Catch Bucket is discarded and the Bucket is replaced. If, now, an object is placed in the Overflow Can, there is an outflow from the Can into the Catch Bucket which exactly equals the volume of the body.
Overflow Can and Catch Bucket . . . . . **.90**

31–20 OVERFLOW CAN . . . . . **.55**

31–21 CATCH BUCKET . . . . . **.35**

31–23 LOADED WATERPROOF WOODEN CYLINDER, adapted for use in Displacement and Density experiments.
This is a cylinder loaded to just sink in water, with a water-proof paraffine finish. It is especially adapted, from its size (3¼ inches by 1⅝ inches diameter), for use with Overflow Can No. **31–20** . **.16**

31–25 WATERPROOF CHERRY BLOCK, useful as specimen for measurement as well as for experimentation and density work.
This block is made of cherry with sandpaper finish and paraffined to make water-proof. Its size is 3 × 3 × 1½ inches thick, which makes it especially adapted for individual student work . . . . **.11**

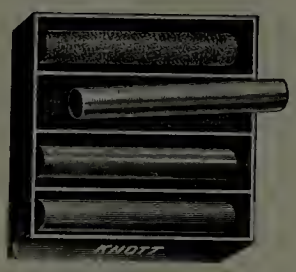
31–27 LOADED WATERPROOF RECTANGULAR BLOCK for Displacement and Density experiments.
This is a block, 1¾ inches square by 2¾ inches high, loaded to just sink in water and made water-proof by boiling in paraffine . . . . . **.18**

31–35 LEAD SINKER for determining the Specific Gravity of Lead, and for use as Sinker in determining the Specific Gravity of an object lighter than water.
This Sinker is of uniform density and of convenient mass and size for use in Density experiments. It is provided with small brass hook for suspension . . . . . **.13**

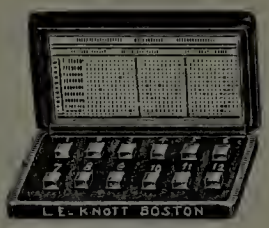
31–40 SULPHUR SPECIMEN for the determination of the Specific Gravity of Sulphur.
This is a specimen about 3 inches long by 1½ inches in diameter . . . . . **.06**

31–45 SPECIFIC GRAVITY DETERMINATION GROUP, consisting of Nos. **31–20** to **31–40** **1.54**

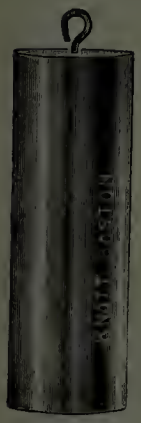
No. 31–55



No. 31–67



No. 31–80



No. 31–60

No. 31–85

No. 31–105

31–55 PURE ALUMINUM BLOCK, of commensurable volume for use in determination of the specific gravity of aluminum, of a liquid by buoyancy method, of a solid lighter than water by the sinker method. This is a cubical block of cast metal, 1½ inches on an edge $0.60

31–60 ALUMINUM CYLINDER, after Millikan, Gale and Bishop's "Laboratory Physics" (Experiment 6) 54

31–65 PARAFFINE CUBE for density experiments. This is a cast cube of paraffine, measuring 5 centimeters on an edge and weighing approximately 100 grams 27

31–67 SPECIFIC GRAVITY SPECIMENS for mensuration and specific gravity work.
These specimens are rods of ½ inch diameter, 2 inches long, accurately machined. The set consists of aluminum, brass, steel, and hard rubber, enclosed in small cardboard box 85

31–67a ALUMINUM ROD, ½ × 2 inches 24

31–67b BRASS ROD, ½ × 2 inches 18

31–67c STEEL ROD, ½ × 2 inches 16

31–67d HARD RUBBER ROD, ½ × 2 inches 29

31–70 SPECIFIC GRAVITY SPECIMENS, twenty different substances of irregular shape, of convenient size for individual student work in density. In cardboard box 65

31–80 SPECIFIC GRAVITY SPECIMENS for exact determinations of volume by direct measurement; also for determination of density by measurement of mass, illustrating by direct comparison the relations between volume, mass and density.
These specimens consist of twelve cubes, accurately machined to exactly one centimeter on an edge, thus giving a volume of one cubic centimeter. The mass, therefore, of each cube will be the density. The set consists of the following specimens, — one each of magnesium, aluminum, zinc, tin, iron, nickel, copper, silver, lead, and alloys of copper and zinc, copper and aluminum, and copper and tin. Each set is enclosed with index in a velvet-lined case 9.85

31–85 SPECIFIC GRAVITY SPECIMENS for showing that lengths are inversely proportional to specific gravity when comparing substances of same diameter and mass; also, for exact determinations of volume by direct measurements.
These specimens consist of twelve cylinders, machined to exactly 5 millimeters in diameter and length, adjusted to weigh exactly 10 grams. The set consists of same metals as listed under No. **31–80,** enclosed in velvet-lined hinged case, with index on under side of cover 10.85

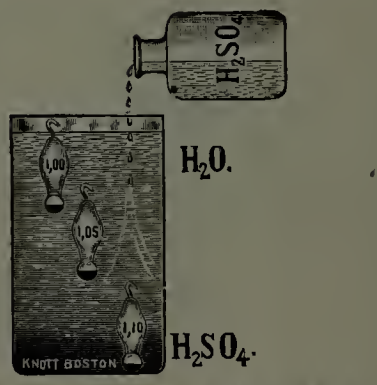
31–97 WATERPROOF WOODEN ROD for determination of the specific gravity by the flotation method. This is a rod of wood of uniform density, 20 centimeters long, 1 centimeter in diameter, coated with paraffine to make waterproof 06

31–100 BRASS SUPPORT for holding No. **31–97** in vertical position.
This is a spring brass support, designed to clamp securely on the side of a battery jar and to hold No. **31–97** in an erect position by means of two aligned round sockets 17

31–105 DENSITY BY FLOTATION APPARATUS consisting of Nos. **31–97** and **31–100** with No. **31–265c** Glass Jar, complete 63

No. 31–125

No. 31–131



No. 31–150

No. 31–145

No. 31–135

No. 31–140

No. 31–160

31–125 SPECIFIC GRAVITY BOTTLE WITH THERMOMETER STOPPER for determination of the specific gravity of a liquid by the weight of a measured quantity; capacity 50 cubic centimeters . **$2.75**

31–130 SPECIFIC GRAVITY BOTTLE WITH CAPILLARY STOPPER for determination of the specific gravity of a liquid by the weight of the measured quantity. Capacity 25 cubic centimeters, accurately adjusted . . . . . **.67**

31–131 ——, same as above, capacity 50 cubic centimeters . . . . . **.92**

31–132 ——, same as No. **31–130,** but unadjusted . . . . . **.30**

31–135 SPECIFIC GRAVITY BOTTLE. This is a small, glass-stoppered bottle of convenient size frequently desired by instructors in preference to the especially adapted types . . . . . **.10**

31–140 SPECIFIC GRAVITY BOTTLE WITH CAPILLARY STOPPER, double-walled and evacuated. Capacity 25 cubic centimeters **2.15**

31–145 HARE'S BALANCING COLUMNS APPARATUS. This apparatus consists of a support at the top of which is mounted a special lead tube with three branches. To the two outside branches are attached two lengths of glass tubing; to the central, the tubing through which the air is to be exhausted from both tubes.

Complete as illustrated, with clamp, two jars, glass and rubber tubing connections and pinchcock, but without upright support . . . . . **.95**

31–145a SPECIAL LEAD PIECE WITH THREE BRANCHES . . . . . **.27**

31–145b GLASS TUBES . . . . . Per Pair **.20**

31–145c PINCHCOCK . . . . . **.20**

31–145d GLASS JARS . . . . . Per Pair **.20**

31–145e UPRIGHT SUPPORT AND CLAMP **1.75**

31–145f SUPPORT CLAMP as used in above **48**

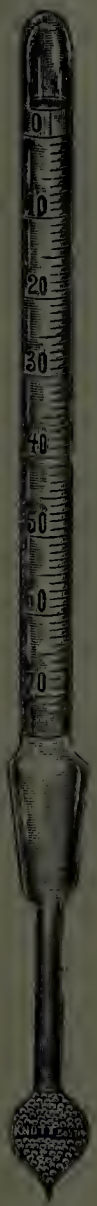
31–150 SPECIFIC GRAVITY PLUMMETS for Lecture Table use.

This apparatus consists of twenty-seven plummets indicating by sinking or floating, Specific Gravities ranging from **.7000** to **2.000** by steps of **.0500.**

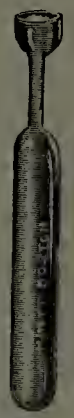
On the demonstration desk, if placed in a liquid in a tall jar, and other liquids which do not mix are carefully placed in this jar, a spectacular result follows. . . . . Duty Free **9.85**

31–160 DENSITY INDICATING BALL for illustrating the changes in the density of a liquid induced by variations in temperature.

This is a metal ball 75 millimeters in diameter, nicely adjusted to float in cold water, but which will sink in warm water **3.85**



No. 31–227



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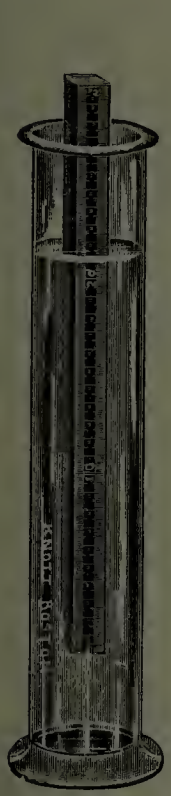
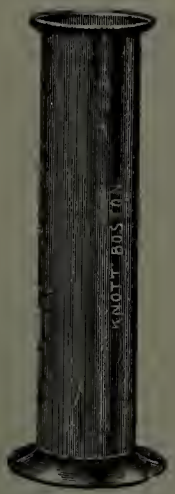


No. 31–232

No. 31–240

No. 31–242



No. 31–250

No. 31–265

No. 31–170

31–170 **HYDROMETER (CONSTANT WEIGHT),** for finding Specific Gravity of light liquids, Beaumé's Scale 70-10, Specific Gravity Scale 0.7000 to 1.000 . . . . . **$0.60**

31–171 **HYDROMETER (CONSTANT WEIGHT),** for heavy liquids, Beaumé's Scale, 0-70, Specific Gravity Scale 1.000 to 2.000 . . . . . **.60**

31–175 **HYDROMETER (CONSTANT WEIGHT),** for both light and heavy liquids **1.25**

31–225 **CONSTANT VOLUME HYDROMETER TUBE,** after Millikan, Gale and Bishop's "Laboratory Physics" . . . . . **.33**

31–227 **CONSTANT WEIGHT HYDROMETER TUBE,** after Millikan, Gale and Bishop's "Laboratory Physics," for determining the Density of a Liquid by the flotation method . . . . . **.44**

31–230 **DEMONSTRATION HYDROMETER,** illustrating the principle of the hydrometer and the method of determining the specific gravity of liquids by buoyancy.
This is a paraffined rod, 30 centimeters in length, 1 square centimeter cross section, graduated the entire length to millimeters. Without Jar . . . . . **.20**

31–232 ——, with Jar . . . . . **.75**

31–240 **NICHOLSON'S HYDROMETER** for determining the Density of a Body Heavier than Water.
This is a Constant Volume Hydrometer constructed of metal. It consists of a hollow cylinder attached to the lower end of which is a basket heavy enough to keep the cylinder upright; at the upper end is a vertical rod carrying a pan for holding weights. Without Jar **1.95**

31–242 ——, same as above, but made entirely of glass. Recommended for lecture use. Without Jar . . **2.95**

31–250 **CLEAR WHITE GLASS HYDROMETER JARS** for use where a tall jar of small diameter is desired.

	a	b	c	d	e
Size, inches .	12 × 1½	12 × 2	15 × 2	15 × 3	18 × 3
Price . . .	**$0.50**	**$0.55**	**$0.80**	**$1.00**	**$1.35**

31–265 **GLASS JARS,** of excellent quality.

	a	b	c	d
Size, inches .	2¼ × 3¼	4 × 5	6 × 8	8 × 12
Price . . .	**$0.12**	**$0.25**	**$0.40**	**$1.50**

PRESSURE OF LIQUIDS

No. 20–251

No. 20–260

No. 32–30

No. 32–35

20–251 INCOMPRESSIBILITY OF LIQUIDS APPARATUS, IMPROVED DESIGN, for the quantitative observation of the incompressibility of liquids.

This apparatus consists of a tube with indicating capillary. The liquid to be observed should fill the short arm of the tube and should rise in the long arm to near the top of the capillary. If mercury is poured into the long arm, the liquid, if compressible, will indicate the amount, if any, in the capillary.

This tube may be mounted on our No. **41–116** Boyle's Law Stand. Tube only **$2.50**

20–260 SCREW ADJUSTMENT INCOMPRESSIBILITY OF LIQUIDS APPARATUS for showing elasticity and incompressibility of liquids.

This apparatus consists of a support which answers the double purpose of supporting a plunger and a bottle as well as that of a clamp.

In use, the bottle is filled with the liquid, a one-hole rubber stopper placed in the neck, the end of the plunger placed in the hole and the bottle clamped firmly in place by means of a screw adjustment. If the plunger is now thrust into the bottle, the liquid being incompressible, the bottle will burst.

Complete with three bottles **1.45**

32–30 UNIFORM PRESSURE SYRINGE OF BRASS for demonstrating that the pressure of liquids is equal in all directions against the sides of the containing vessel.

This apparatus consists of a metal sphere to which is attached a brass tube with piston. On the surface of this sphere are "bosses" into which glass tubes are sealed in a vertical position. If the apparatus is filled with water, or any other liquid inactive on the metal, any pressure exerted by the piston will be transmitted in all directions against the inner sides of the sphere. As this pressure is equal in all directions, the water will rise from the glass tubes a uniform distance.

This is a convenient form for the demonstration of the principle involved, and the accuracy of the result and the cleanliness of operation make it a valuable addition to a laboratory equipment . . **12.00**

32–35 UNIFORM PRESSURE SYRINGE for demonstrating that the pressure of liquids is equal in all directions against the sides of the containing vessel.

This is an apparatus similar in design to the above, but made of glass, without the pressure indicating tubes. The equality of pressure is illustrated by the spouting liquid **1.95**

No. 32–50

32–50 PRESSURE GAUGE, with **Equalizing Tube** after Cheston, Dean and Timmerman's "Laboratory Manual of Physics" (Experiment 4), for measuring directly the pressure of liquids at various depths.

This apparatus consists of a Pressure Diaphragm in direct connection with a Manometer, the whole mounted on a wooden scale. This form is an improvement over the old types, in that the level of the liquid in the Manometer may instantly be made the same in both branches by allowing an equality of pressure by opening the horizontal tube noted in the illustration at about the central point **$1.35**

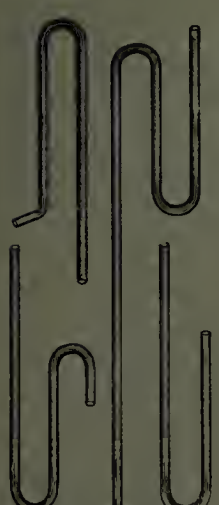
Nos. 32–60 and 32–62

32–60 CHAIN DRIVE PRESSURE GAUGE, HALL'S IMPROVED, for demonstrating that pressure upon a surface varies with the depth but not with the angle of inclination.

This apparatus has been greatly improved to obviate the deteriorating quality of the rubber belt as used in former designs, the universal movement of the pressure chamber being imparted by a chain and sprocket operated by a small crank. Illustration pictures also our No. **32–62** Pressure Gauge Attachment, valuable when it is desired to project the indicating globule on a screen. Pressure Gauge only, without Jar or Attachment **2.80**

32–62 PRESSURE GAUGE PROJECTION HOLDER, as designed by Dr. Hall, for use in the lantern slide carrier in projecting the indicating globule in Manometer Tube of above.

This Holder is designed to fit the Standard Lantern Slide Carrier. The Manometer Tube, as illustrated above, is clamped by two discs eccentrically mounted. The globule shows through the center of the opening. Holder, only **$0.65**



No. 32–75

32–65 PRESSURE GAUGE, simple form, consisting of a pressure chamber in connection with an index tube . . . . . **.18**

32–66 LIQUID PRESSURE GAUGE, after Millikan and Gale, Figure 4 . . . . . **.65**

32–70 GLASS MANOMETER TUBE, after Millikan, Gale and Bishop (Experiment 4) . . . . . **.27**

32–75 PRESSURE TUBES, after Gage's "Introduction to Physical Science," for showing that at same depth pressure is equal in all directions.

The set consists of four tubes, U form, the shorter arms of which open in different directions, — upward, downward and sideways.

In use, an equal amount of mercury is placed in the bends and the tubes thrust into a jar filled with the liquid until the openings of the short arms are all brought at the same depth. The pressure indicated by the mercury registers the same.

Per set of four tubes . . . . . **.95**

No. 32–100 (Fig. 1)

No. 32–100 (Fig. 2)

32–100 **NICHOLS' UPWARD AND DOWNWARD PASCAL'S VASE APPARATUS** for quantitative determintaion of the laws governing liquid pressure, both upward and downward, also, that pressure upon a surface is independent of the shape of the containing vessel.

The apparatus consists of a standard to which are attached the various supporting arms of which three are used in the experiment. (See Fig. **1** above.)

DOWNWARD PRESSURE. This apparatus shows the method of assembling when it is desired to measure the downward pressure, its relation to the size of the surface acted upon, the effect of the amount of liquid in the vessel above the surface and the perpendicular height of the liquid.

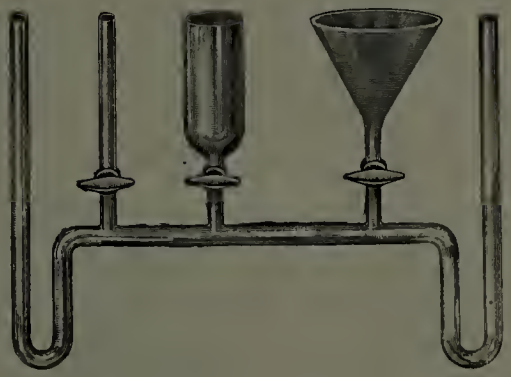
If water is then poured into the vessel, the upward pressure will be indicated by the long arm of the lever moving upward. The amount of pressure may be calculated from the factors obtained by the measurements of the two arms of the lever.

UPWARD PRESSURE. Fig. **2** illustrates how the apparatus is assembled for the study of upward pressure of a liquid on a submerged surface, showing that the upward pressure bears the same relation to the depth as does the downward pressure.

The apparatus is substantial and beautifully constructed throughout. Attractive dark finish with nickel-plated fittings. The design is such as to permit of exact determinations with the least inconvenience in manipulation. We call especial attention to its compactness, stability, and its cleanliness in operation.

Complete with all parts **$18.00**

No. 32–110



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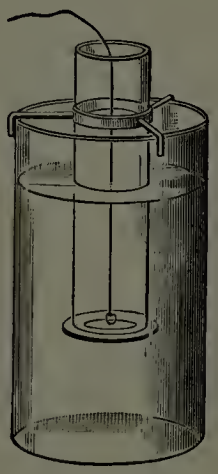
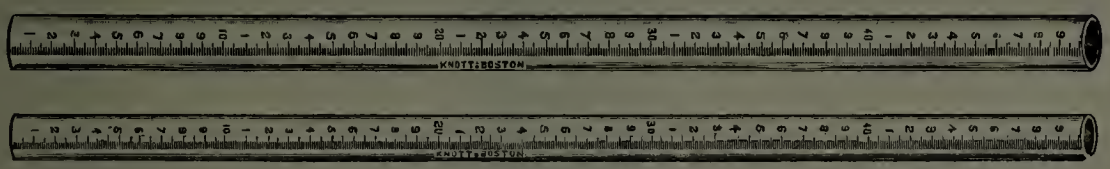


No. 32–120



No. 32–130

32–110 **PASCAL'S VASES WITH BALANCE ARM AND WEIGHT** for demonstrating that pressure is independent of the shape of the containing vessel.

The apparatus consists of a casting for supporting the vessels of different shapes, also for a standard which carries at its top a pivoted lever, on the short arm of which may be attached a hanger bearing a brass disc the surface of which is ground to fit a cylindrical part of the casting above mentioned.

In use, the hanger is balanced by placing weights on the long arm of the lever. An index attached to the standard indicates the height of the water in the vessel.

The hanger is attached to the arm of a balance.

Complete, as illustrated with jar and three vessels of different shapes, balance arm and weights . . **$6.35**

32–115 **PASCAL'S VASES WITH MERCURY INDICATOR** for demonstrating that pressure is independent of the shape of the containing vessel, depending only on the area pressed upon.

The illustration pictures an instrument made entirely of glass. It consists of three differently shaped vessels, each connected through stop-cocks of equal bore to a common tube terminating at each end in manometer tubes, which, in use, have their bends filled with mercury, which acts as the pressure indicator.

This instrument has become popular from its quality of being self-contained. Besides its extreme sensibility, its convenience in operating and its cleanliness, this instrument is commended for the rapidity with which it can be operated **5.75**

32–120 **BUOYANCY OF LIQUIDS APPARATUS** for illustrating vertical upward pressure.

This apparatus consists of a glass disc the surface of which is ground to fit the lower rim of a glass cylinder. In use, this disc is held in junction to the cylinder by means of a string attached to the center of the disc until a buoyancy pressure sufficient to counteract the weight of the disc is reached. This pressure may be measured by carefully pouring water into the cylinder until the mass equalizes the buoyancy pressure of the liquid on the disc.

Complete as illustrated, with jar, glass cylinder, disc, and support for cylinder **1.64**

32–130 **LIQUID PRESSURE TUBES,** after Chute's "Physical Laboratory Manual," Problem **52**, for verifying the Laws of Liquid Pressure.

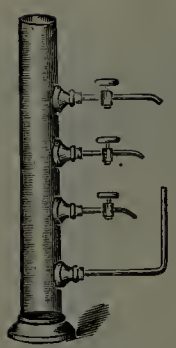
These tubes are of glass, 50 centimeters long, of different diameters, graduated into millimeters along their entire length, the zero of the scales being at the closed ends . . . . . Per Pair **2.75**

32–132 **CYLINDRICAL GLASS VESSEL** for use with above Liquid Pressure Tubes **2.50**

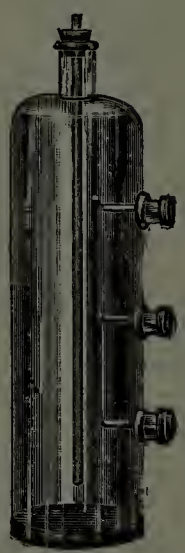
32–134 **LOADED GRADUATED LIQUID PRESSURE TUBE,** after Fuller and Brownlee . . . . . **.35**

32–135 **PRESSURE U-TUBES** for experiments in Fluid Pressure, consisting of tubes with arms of equal lengths.

	a	b	c	d	e	
Length . . .	10	12.5	15	30	50	centimeters
Price . . .	$0.14	.16	.18	.30	.60	



No. 32–150



No. 32–160

No. 32–165

32–150 TORRICELLIAN LAW APPARATUS for determination of the law s equals $\sqrt{2gh}$, where s equals the speed of efflux, g the value of gravity and h the height of the liquid; also for simple demonstration of variable pressure according to depth below the free surface of the liquid.

This apparatus consists of a tall glass cylinder with lateral openings, three closed by stop-cock tubes, the fourth terminating in a tube with a vertical branch which may be stopped by rubber tubing and pinchcock. If the liquid is allowed to issue vertically it will rise to nearly the height of the free surface of the liquid in the jar. This height would be the same except for the friction at the orifice, the weight of the falling liquid and the resistance of the air. By turning the stop-cocks in the other lateral tubes, allowing the liquid to issue forth, it will be noted that the pressure varies as the depth of the orifice below the free surface, the paths of the issuing stream following a parabolic curve due to the force of gravity. By observation and calculation it may be determined that the focus of these parabolic curves is as much below the orifice as the surface of the liquid is above it and that the curves are flatter the greater the pressure under which they issue.

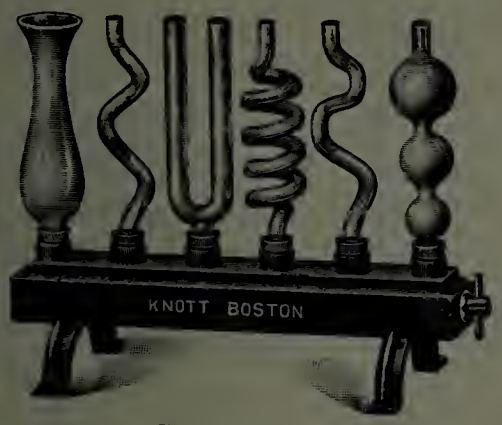
Complete as illustrated $7.90

32–160 MARIOTTE'S BOTTLE, after Hall & Bergen's "A Text-Book of Physics," page 44, for the study of Fluid Pressure at varying levels.

Complete as illustrated, with rubber stoppers and glass fittings 3.75

32–165 EIGHT-IN-ONE APPARATUS, after Gage's "Introduction to Physical Science" (Experiment **32**) for the study of the Torricellian Laws, as described under No. **32–150.**

This apparatus, advised for Lecture Table work, consists of a brass cylinder, 6 feet long, surmounted by a reservoir. At various heights along the tube are attached lateral tubes with screw caps. By the successive openings of these screw caps, the paths of the issuing streams are readily observed. It will be noted that the stream issuing from the lowest orifice shows flattest, thus showing the greatest pressure. The streams issuing from the other orifices all take a curved path, the curvatures, however, depending upon the depths of the orifices below the free surface of the liquid 8.75



No. 32-180

No. 32-185

32-180 **LIQUID LEVEL APPARATUS, IMPROVED FORM,** for illustrating the tendency of a liquid to seek its own level.
This apparatus consists of a cast-iron reservoir with open tubulatures into the top of which are set glass tubes of various shapes and sizes. A liquid poured into the funnel-shaped tube will fill the iron reservoir and rise in the tubes at equal rates and remain at the same height. The U-shaped tube has branches of equal area.
This apparatus must not be confused with other designs. Our design is of substantial construction, handsome in appearance, obviating the inconveniences of less modern types $3.30

32-185 **LIQUID LEVEL COMMUNICATING TUBES** for illustrating the tendency of a liquid to seek its own level.
This apparatus, constructed entirely of glass, consists of four tubes of different shapes and sizes communicating with each other by means of a common connection 75

No. 32-200

No. 32-205

No. 32-215

No. 32-230

32-200 **SIMPLE SIPHON** for the qualitative and quantitative study of the principles involved.
Consists of a glass tube, bent in shape as illustrated. Length of arm, 12 inches $0.20

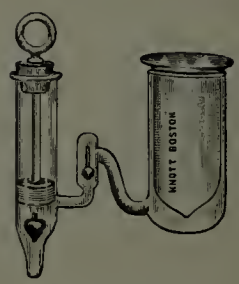
32-205 **SIPHON WITH SUCTION TUBE** 35

32-215 **TANTALUS CUP OR INTERMITTENT FOUNTAIN,** illustrating the principle of Intermittent Springs.
This standard design is in reality a Siphon, the long arm of which is held in a stopper in the constriction of the goblet-shaped glass vessel.
In use, water is led into the goblet. This water will rise in the short arm of the siphon until it reaches the bend, when it will flow down through the long arm of the siphon and continue to flow until the level of the water gets below the end of the short arm. This action will be continuous if the inflow through the siphon is less than the outflow 70

32-230 **CARTESIAN DIVER,** illustrating the different effects of suspension, immersion, and floating.
The apparatus as illustrated is instructive and amusing, as the little figure is susceptible to the least movement of the diaphragm, causing it to go through some very peculiar antics.
Complete as illustrated 80

32-231 **CARTESIAN DIVER,** only 25

No. 34–10



No. 34–20

No. 34–30

No. 34–40

34–10 HYDRAULIC POWER PRESS for illustrating the force of a Hydraulic Press.

The instrument illustrated is more than a model, in that it may be subjected to very severe tests for breaking strengths. It is built of cast iron, bronze and steel throughout, all parts being finished as strikingly as possible. The cylinders are accurately turned and fit perfectly, the large one having an internal diameter of 2½ inches, the small cylinder of the force pump being 1/16 of an inch. In working our design, or in working any design of Hydraulic Press we advise the use of oil, inasmuch as this liquid prevents wear of the working parts.

This instrument has been subjected to very severe strains in our laboratory and each instrument shipped is tested to give the calculated efficiency **$34.50**

34–20 HYDRAULIC PRESS for the study of the principle involved in the Hydraulic Press.

This is the standard simple model of glass, the valves of which are colored so that their operation may readily be observed **1.65**

34–30 SIX-FOOT WATER HEAD HYDROSTATIC BELLOWS for illustrating an application of Pascal's Law.

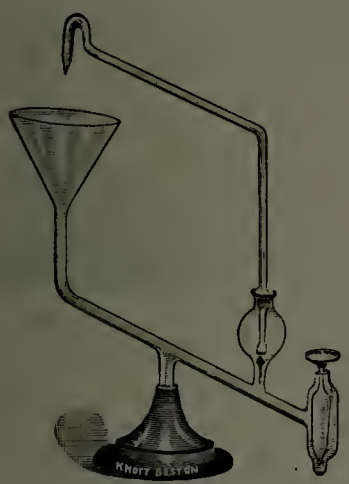
Our design consists of a strongly constructed bellows 30 centimeters square, supported by legs. Attached to this bellows is a brass tube upright, 6 feet long, terminating at its top in a conical reservoir. This upright is separable into two parts as illustrated. All parts are handsomely finished and designed to withstand reasonable strain, the pneumatic bellows being sufficiently strong to hold a person **22.50**

34–40 SEVEN-IN-ONE APPARATUS OR SPIROMETER, GAGE'S IMPROVED, for demonstrating fundamental principles in Pneumatics and Hydraulics.

This apparatus consists of a seamless brass cylinder, 6 inches in diameter, mounted on a metal casting, provided with "bosses," into which rods may be screwed from either side. The cylinder is provided with an ingeniously designed piston which, owing to its construction, has greater efficiency, the longer the use. This construction also obviates the sticking of the washers and leakage around them. Each instrument is provided with our detachable handle in the piston head, a fixed handle with brass stopcock, and nipple. This apparatus, as implied from the name "Seven-in-One," will illustrate the principles involved in seven different instruments, as follows: — Hydraulic Lift, Hydraulic Press, Incompressibility of Liquids Apparatus, Pascal's Law Apparatus, Pneumatic Lift, Hydrostatic Bellows, and Magdeburg Hemispheres.

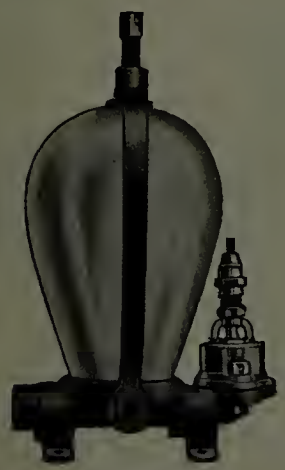
It is handsomely finished in nickel plate and is furnished complete with rods for supports **8.90**

RAMS — PUMPS



No. 35–10

No. 35–15 (Sectional View)



No. 35–20

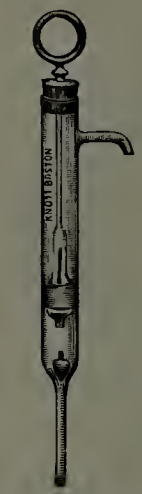
No 35–15

35–10 HYDRAULIC RAM, illustrating the increase of pressure due to interrupted flow in a stream of water. This model is made entirely of glass, with black glass valve. It is mounted on a wooden base; its size, 17 × 13 inches, is ample for lecture hall demonstration **$3.95**

35–15 HYDRAULIC RAM, commercial form. By referring to the sectional view it will be noticed that it consists of an Air Chamber A, the Body B, and the Snifting-Valve for Air Inlet C. The Check or Inlet Valve E is located between the supply pipe and the air chamber. The Impetus Valve F is located at the end of the supply pipe.

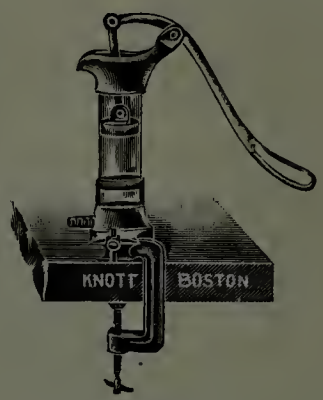
The water flowing through Supply Pipe G passes through the outlet in the impetus valve until the increasing velocity creates sufficient pressure to close the valve checking the flow of water in this direction, and to force open the Check Valve E. The water having passed into the air chamber, is then forced through the Delivery Pipe H by the increased pressure on the air chamber. After forcing the water into the air chamber, the pressure is relieved and the impetus valve opens, only to go through the operation again and again, continually delivering water. A supply of from 2 to 3 gallons per minute is required to operate this valve successfully. Size of drive pipe, ¾ inch; discharge pipe, ½ inch diameter; total approximate weight 27 pounds. Capacity 60 to 100 gallons per hour to a height of 60 feet **11.00**

35–20 COMMERCIAL DEMONSTRATION HYDRAULIC RAM, similar in construction to No. **35–15**, yet it has vastly greater pedagogic value in that the air chamber is of glass, permitting view of the working parts in actual operation without in the least taking away from its practical commercial value **18.00**



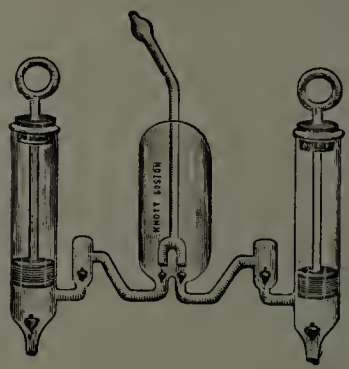
No. 35–30

No. 35–32



No. 35–50

No. 35–52



No. 35–40

No. 35–55

35–30 **MODEL OF LIFT PUMP,** entirely of glass with colored glass valve, with ground seat. Total length 15 inches **$1.60**

35–32 **MODEL OF FORCE PUMP,** made entirely of glass, with black glass valves, with ground seats . . **1.95**

35–40 **FIRE ENGINE PUMP,** illustrating the practical application of the simple force pump.
This pump is in reality a double force pump with a central reservoir having a discharge tube. Its practical application will be found in the walking beam fire engine pump.
This model is entirely of glass, the valves being constructed of black glass with ground glass seats . . **2.25**

35–50 **T-BEAM WATER LIFT PUMP** for use with our No. **5–1000** Universal T-Beam Basic Clamp "A."
In this design, we present a pump that is patterned after commercial forms, constructed so that all working parts are in full view. Cylinder 1½ inches diameter, capable of lifting a large amount of water.
Without Clamp **7.85**

35–52 **T-BEAM WATER FORCE PUMP** for use with our No. **5–1000** Universal T-Beam Basic Clamp "A."
This pump has the same commendable features as the above.
Without Clamp **7.85**

NOTE. These Pumps may be used the same as the old form of metal-fitted glass cylinder pumps in case the T-Beam Clamp is not provided. When so used, the attachment serves as a broad, flat base for supporting. The T-Beam Clamps for holding the pumps rigidly to the table will, however, prevent accidental breakage and will be found a wise investment.

35–55 **T-BEAM LIFT AND FORCE PUMPS WITH TANK.** This outfit includes the Lift and Force Pumps Nos. **35–50** and **35–52** above and the T-Beam Basic Tank No. **35–57** below.
Complete outfit **$21.45**

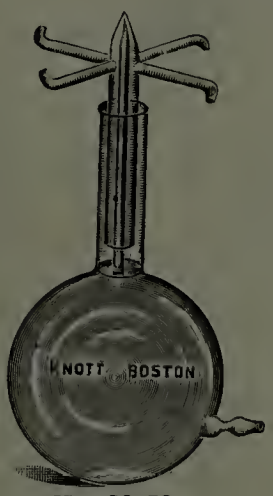
35–57 **T-BEAM BASIC TANK.** This tank is the same as furnished in above. It is a special casting with side brackets each with double-beveled lathe-rest slides for the interlocking bases of the pumps. It has a durable black finish and presents a pleasing appearance in the laboratory.
Its use as a general water tank for many experiments should not be overlooked **5.75**

No. 35–75

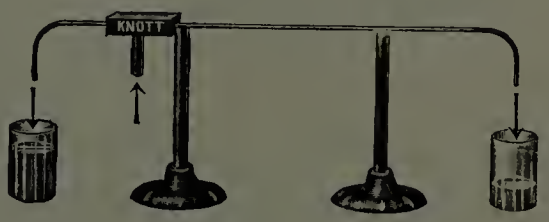
35–75 MODELS OF VALVES. In the models above illustrated, we demonstrate the most important valve types, as follows, — **butterfly valve, bellows valve, round spring valve, conical valve** and **oil silk valve.** These models are ample in size for lecture work and follow closely the commercial types. Each 6 inches in diameter, carefully made and neatly finished.
Per set of five as above **$5.50**

No. 36–12

No. 36–30



No. 36–50



No. 36–75

36–12 HERO'S FOUNTAIN, illustrating the raising of water by the elastic force of air. Made entirely of glass, in form as illustrated.
In operation, the upper bulb is first filled with water, the lower with air. The fountain is started by pouring a small quantity of water into the reservoir. As this flows down, it exerts a pressure on the air contained in the lower bulb. This pressure is transferred to the water in the upper bulb and forces it out through the fountain nozzle **$2.70**

36–30 REACTION APPARATUS, illustrating the reactive force of a laterally escaping stream of liquid.
The apparatus consists of a glass reservoir with fused-on glass indicator at the bottom and a small opening through which the liquid may flow at the side. If the reservoir is suspended and filled with water, the reactive force of the issuing liquid through the opening above mentioned will cause a movement opposite to that in which the water is flowing.
Complete as illustrated, with stationary indicating point **1.00**

36–35 ACTION AND REACTION APPARATUS, after Hall, No. XLV **1.40**

36–50 REACTION GAS AND FLAME WHEEL for determining the reaction set up by gas escaping from a lateral opening.
The slightest flow of a gaseous body, from whatever cause, passing through the four horizontal arms will cause a reaction on the same principle as in Barker's Mill. If the illuminating gas issuing from these four orifices be ignited, the effect is spectacular in the extreme.
Price complete, as above illustrated **2.50**

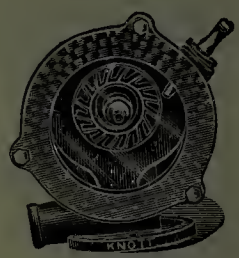
36–75 APPARATUS FOR STUDYING WATER FRICTION IN PIPES, designed by Professor E. H. Hall of Harvard University, for studying the effect of the friction in pipes, tending to impede the flow of liquids.
As indicated in the diagram, both branches of the liquid tube have the same liquid pressure impressed upon them, pipes being of the same size, differing only in length, while the amount of water which passes through the long pipe is approximately one-half that which passes through the short pipe.
Without glasses **2.25**

36–100 ACTION AND REACTION STRIP, after Hall (Experiment **XLVI**) . . . . . **.95**

WATER TURBINES—WATER WHEELS

No. 37–16

No. 37–20



No. 37–30

37–16 DEMONSTRATION MODEL OF A TURBINE. This is an illustrative model for the teaching of the fundamental parts of a Water Turbine. It is substantially constructed of glass and metal, all working parts being in full view. The central shaft transmits motion through miter gears to a horizontal shaft which carries a pulley wheel which may be connected to show power.

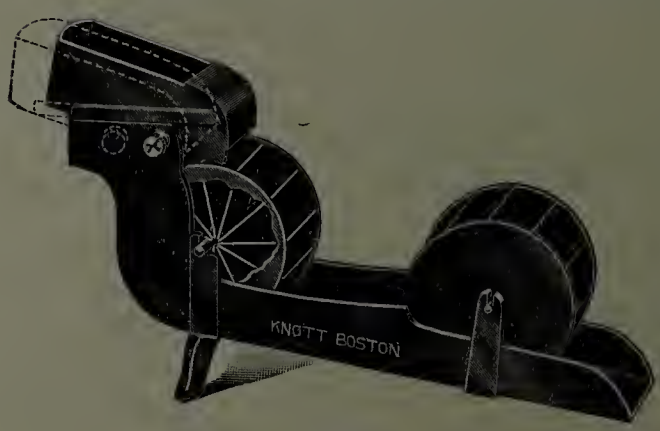
This model is handsomely finished and substantially constructed. It is 42 centimeters high, — ample for clear view from all parts of the ordinary lecture room . . . . . .Duty Free **$52.75**

37–20 MODEL OF A WATER TURBINE for connection to a water pump.

This is of simple construction of glass and brass illustrative of same principles involved in more expensive models **4.50**

37–30 MODEL OF WATER TURBINE. This model from its design is especially adapted to lecture work. It is sufficiently large for class demonstration and yet will develop power for demonstrating the commercial value of a turbine. On the demonstration side it has the feature of a glass front which allows full inspection of all working parts. The model is carefully constructed and handsomely finished, the parts within painted a distinguishable color. It is mounted on a firm supporting base **13.50**

37–50 CAST METAL WATER WHEEL MODEL for study and demonstration of the overshot, undershot, and breast water wheels. In our design, which must not be confused with types on the market, we furnish not only an accurately constructed instrument but one that is durable and handsome in appearance. Our runway is cast of metal and neatly finished. The reservoir, also of cast metal, is peculiar in design in that, by the use of one water wheel, we can by changing its position demonstrate either the overshot or undershot wheels. As illustrated, the model is set up for an overshot wheel. If desired to demonstrate an undershot wheel the water reservoir must be moved back to position indicated by dotted line and the water wheel reversed.



No. 37–50

As may be noted from our illustration this model is distinctive in design, scientifically constructed, and we have no hesitancy in claiming for it a place in a catalogue of scientific instruments. Its substantial structure, symmetry of lines, and handsome appearance will recommend it to all . **5.90**

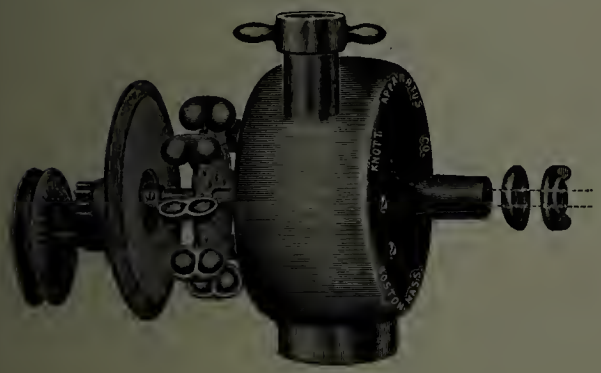
No. 37–60

37–60 EXTENSION HEAD BARKER'S MILL for demonstrating the horizontal pressure of a liquid on the containing vessel.

The design above illustrated has features which obviate all annoyances of the existing types, facilitate the proper cleanly conduct of the experiment, and present a handsome and scientific appearance.

This apparatus stands about 3½ feet high, is handsomely finished throughout and ranks well with other scientific instruments **$4.50**

WATER MOTORS



No. 38–20

No. 38–25

38–20 THE IMPROVED WALTHAM COUNTERSHAFT GEARED WATER MOTOR. A ⅙ H. P. Motor, of more expensive design than the ones listed below, but one which we strongly recommend for the reason that it illustrates most effectively not only the simple water motor, but also the water motor of greatest efficiency, the speed of greatest efficiency, the relation of speed to water flow, the advantages of the direct drive and gear drive, and the application of the prony break to power generators.

The success of this motor depends upon the following features:

FIRST. The employment of the well-known reacting bucket-wheel which has proven by a series of scientific tests to give the highest efficiency in a wide range of work.

SECOND. The reducing gear which enables the wheel to give very much more power, the wheel itself running at its normal speed for greatest efficiency.

THIRD. A gear which is easily thrown in and out of mesh so that it may be used or not, as desired.

The motor which we here offer is the first satisfactory attempt at providing a water motor which will give efficient results under a wide variety of conditions. The uses for such a motor in the science laboratory are numerous, taking the place of the whirling table, supplying small power for the small size electric generators, the operating of stirring devices, and the study of the efficiency test by means of the prony break.

This motor is particularly well adapted to the break-test work in view of the geared driver, enabling two separate and complete series of tests to be made on the same instrument, thus offering a valuable series of efficiency tests on both motor and gears **$9.80**

38–25 THE HARCOURT ⅛ H. P. DIRECT DRIVE WATER MOTOR, a substantial, attractive, well-built motor of careful design and giving unusual power for its size. Less substantially built motors are sold in the hardware trade, but should not be confused with the class of motor which we here offer. Motor complete with 4-inch beveled-face emery wheel, cloth buffing wheel, cake of polish and the grooved wooden pulley. Motor and parts securely packed for shipment in a wooden box . . . **5.00**

38–26 HARCOURT ¼ H. P. DIRECT DRIVE WATER MOTOR, same as above described without accessories, but larger **8.00**

38–27 STUD SHAFT to slip over the motor shaft of above motor. This shaft has the same threaded end as the ⅛ H. P. motor shaft and all the accessories for this motor can be used on the ¼ H. P. motor simply by the addition of the stud shaft **1.25**

38–29 WATER MOTOR ACCESSORIES, as supplied with our ⅛ H.P. Motor, No. **38–25.** These accessories may be attached to our ¼ H. P. Motor No. **38–26** by means of above stud shaft. These accessories are as follows:

1 Cloth Buffing Wheel
1 Beveled-face 4-inch Emery Wheel
1 Cake Brass Polish
1 Grooved Wooden Pulley

Per Set **2.00**

No. 39–10

No. 39–15

39–10 **DEMONSTRATION COMPRESSION BIBB.** This is a common type of brass commercial hose bibb cut open to best show interior mechanism and facilitate the demonstration of the operation of a standard faucet of compression type **$1.25**

39–15 **DEMONSTRATION FULLER BIBB,** — cut away as above to demonstrate the operation of a standard faucet of Fuller type **1.25**

PNEUMATICS

ELEMENTARY PROPERTIES OF MATTER

No. 40–10

No. 40–22

40–10 **BAROSCOPE GLOBE AND BALANCE** for demonstrating that air has weight. This apparatus consists of a carefully constructed sensitive balance, to one arm of which is attached a hollow brass globe, 4¼ inches in diameter; to the other a counterpoise weight, exactly balancing the globe when filled with air. This brass globe is fitted with stop-cock with male screw, provided with hook for attachment to beam of the balance.

In use, the globe is exhausted by means of some efficient air pump. It is then attached to the beam of the balance, when it will be readily noted that the air which was within the globe had weight, inasmuch as the balance is destroyed.

Balance complete with brass globe and counterpoise **$6.65**

40–15 ——, same as above, except that a glass globe is furnished in place of the brass **6.30**

40–17 **BAROSCOPE BALANCE** for use with Weight of Air Globe.
This balance is the same as used with Nos. **40–10** and **40–15** except that no counterpoise is furnished **3.75**

40–18 **BAROSCOPE GLOBE AND COUNTERPOISE,** of brass with stop-cock and hook as used in No. **40–10** **2.95**

40–19 ——, of glass with stop-cock and hook as used in No. **40–15** **2.55**

40–22 **THE COMBINED BAROSCOPE GLOBE AND BELL IN VACUO,** a glass globe 4¼ inches in diameter fitted with brass cap and stop-cock with hook. In the interior is a small bell **5.40**

No. 40–25

No. 40–35

No. 20–200

No. 40–90

40–25 **BAROSCOPE GLOBE,** entirely of glass with hook and stop-cock . . **$2.45**

40–35 **TWO-LITER BAROSCOPE BELL GLASS** for determining the weight of air, also of any gas.
This consists of a globe connected to a bell glass through a stop-cock. **6.45**

40–55 **BAROSCOPE BOTTLE** for determining the density of air. This consists of a bottle of about 2-liter capacity, fitted with a two-hole rubber stopper, glass and rubber tubing connections.
The proper conduct of this experiment requires the use of an air pump, a platform scale with weights, and a barometer, as described in our National Physics Course (Experiment **M260**) . . . . . **.80**

40–90 **OSMOSIS BULB** for showing the diffusion of gases.
This consists of a hollow globular-shaped vessel with neck, constructed of a porous material which permits of rapid diffusion.
About 70 millimeters diameter . . . . . **.70**

No. 20–220

20–200 **ENDOSMOMETER** for illustrating the phenomena of Endosmose and Osmose.
The apparatus consists of a glass vessel the lower end of which is covered with a membrane, the upper end of which is connected to a glass tube which carries a scale. This vessel is supported so that the membrane is held under solution during examination.
All parts complete as illustrated **$3.70**

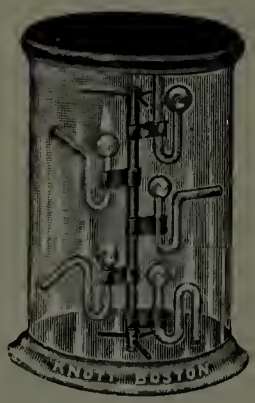
20–215 **STUDENTS' OSMOSIS APPARATUS** for qualitative as well as quantitative work in Osmosis.
The apparatus consists of an Osmosis Tube of design as illustrated, held adjustably in a nickel-plated clamp which may be clamped to the side of a jar. One end of the osmosis tube is closed by a thin porous membrane which may be removed and replaced from time to time as needed.
Apparatus complete as illustrated . . . . . **.$1.25**

No. 20–215

20–220 **OSMOTIC PRESSURE TUBE,** after specifications by Prof. Thomas B. Freas of the Department of Chemistry in Columbia University, for the rapid illustration of the phenomenon of Osmotic Pressure.
This ingenious device consists of an S. & S. Diffusion Shell attached to a glass chamber which ends above in a heavy wall barometer tube 5 feet long. Entering this chamber is another tube with funnel end and stop-cock through which the solution is allowed to flow.
For rapidity of illustration this apparatus is not excelled and the results obtained are very noticeable within fifteen minutes from the start. Complete with Diffusion Shell **3.90**

20–222 **DIFFUSION SHELL,** as used in above apparatus . . . . . Each **.40** Per Lot of 10 **$4.00**

No. 41–10



No. 41–20

No. 41–40

No. 41–60

No. 41–71

No. 41–70

41–10 MERCURY STORAGE FUNNEL for storage and delivery of mercury in a cleanly condition. Mercury is stored in the reservoir, the unclean, lighter and foreign substances rising to float as a scum. The clean mercury is delivered from the bottom by the pressure of the piston shown in the illustration.
This instrument, some 8½ inches high, will be found of the greatest service in any laboratory where clean mercury is in constant demand **$2.00**

41–20 GAS PRESSURE APPARATUS for showing that the pressure upon a gas is transmitted equally in all directions.
If slight pressure is exerted on the rubber diaphragm, this pressure is communicated equally to the open ends of each of the five manometers.
Complete as illustrated **5.80**

41–40 HALL'S FRICTION OF AIR APPARATUS, designed by Professor E. H. Hall of Harvard University for showing very clearly the relative friction of air passing through long and short pipes. Complete as illustrated, including rubber tubing and mouthpiece **2.90**

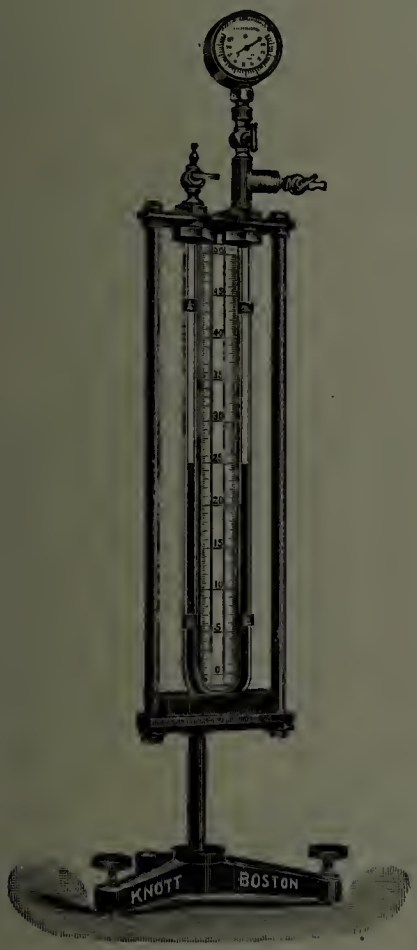
41–60 PRESSURE GAUGE for steam or air pressure. Enclosed in iron case with nickel-plated ring, diameter of dial 3 inches, for pressures up to 150 pounds **3.75**

41–65 VACUUM GAUGE, same quality as above, tested and graduated to read a vacuum from 0 to 30 inches of mercury. Enclosed in iron case with nickel-plated ring, diameter of dial 3 inches **3.50**

41–70 DEMONSTRATION PRESSURE AND VACUUM GAUGE with silvered metal graduated scale; highest quality, glass front permitting full view of the mechanism. May be used under a bell glass or connected directly by tubing to a pressure or vacuum chamber. Diameter 5 inches; graduated to read 0-75 pounds per square inch (approximately 150 pounds pressure) and 0-30 inches **9.60**

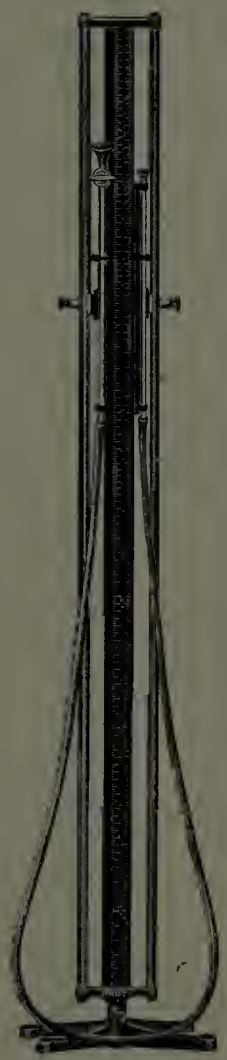
41–71 DEMONSTRATION BOURDON GAUGE. The essential features of the Bourdon Gauge mounted so that its working mechanism is instantly understood. Mounted as illustrated **2.90**

41–72 COMBINATION PRESSURE AND VACUUM GAUGE, enclosed in iron case. Reads 0-75 pounds per square inch and 0-30 inches **6.60**



No. 41–100

No. 41–105



No. 41–110

41–100 BOYLE'S LAW APPARATUS for the accurate determination of Boyle's Law up to ten atmospheres of pressure.

This apparatus consists of a frame mounted on an upright support. This frame holds a sensitive manometer with a carefully graduated scale with clear and distinct graduations and figures. The pressure is introduced through the stop-cock shown at the left and indicated by the small pressure gauge shown at the top.

This instrument is handsomely finished, occupies but little space, being but 1 meter high, and is capable of very accurate determinations **$24.50**

41–105 ADJUSTABLE SCALE BOYLE'S LAW APPARATUS, after Crew and Tatnall's "Laboratory Manual of Physics," Exercise 37, for determining Boyle's Law of pressures ranging between one-half and two atmospheres **4.95**

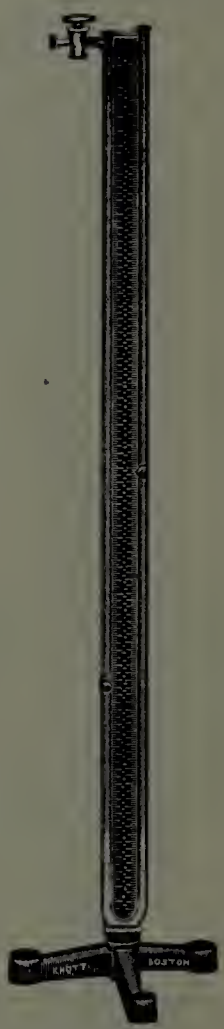
41–106 COMPRESSION PUMP, especially adapted for use with above . . . . . **.25**

HAND AIR PUMP, recommended for use with No. **41–105** Boyle's Law Apparatus. For description and illustration, see Section **42**.

41–110 FIVE-FOOT ADJUSTABLE BOYLE'S LAW APPARATUS for the determination of Boyle's Law.

The apparatus consists of a metal frame with scale mounted on our H Base, the tube carriers consisting of wooden strips attached to special clamps in such a way that there is a perfect alignment at all times relative to the scale. Each tube is provided with a movable brass indicator for registering the heights of the columns of mercury. Instead of the tube with the closed end, we are supplying a tube closed with an air-tight glass stop-cock. This apparatus stands some 150 centimeters high, and being mounted on our special design H Base, is extremely rigid. It is handsomely finished in japan and nickel-plate.

Complete as illustrated **9.00**



No. 41–113

No. 41–115

Nos. 41–155 and 41–160

No. 41–157

41–113 **KNOTT'S ADJUSTABLE SCALE BOYLE'S LAW AND BAROMETER APPARATUS** for determining Boyle's Law.
This form of apparatus consists of Miller's Pressure Tube mounted on Adjustable Scale Support as described in the following item, No. **41–115**. The use of this apparatus requires some efficient form of Air Pump. No. **42–75** is highly recommended.
Complete as illustrated, with stand **$3.85**

41–114 **MILLER'S COMBINATION PRESSURE GAUGE,** tube only unmounted **2.00**

41–115 **SIMPLE ADJUSTABLE SCALE BOYLE'S LAW APPARATUS** for the derivation of the law that the product of the Volume of a Gas by its pressure is a constant quantity.
In this, our new form, we have striven to correct mistakes of old types and enhance the value of an inexpensive Boyle's Law Stand. Our stand consists of a finished hardwood backing attached to a casting, which, in turn, is threaded into a neatly finished tripod base. Our improvement obviates the use of cumbersome clips, rubber bands, etc. The tube may be attached or removed in an instant from the above-mentioned wooden back, one sliding brass clip, which also answers the purpose of an indicator, being the only fastening device.
Complete with simple J tube, as illustrated **2.95**

41–116 **ADJUSTABLE SCALE BOYLE'S LAW STAND.** Stand only, as used in above **1.95**

41–120 **EXTRA HEAVY BOYLE'S LAW TUBE,** simple J form, as used in No. **41–115** **1.00**

41–126 **BOYLE'S LAW TUBE,** unfilled, after Millikan, Gale and Bishop (Experiment **9**) . . . . . **.33**

41–130 **TRIPOD, ROD, UNIVERSAL CLAMP AND HOLDER** after Millikan, Gale and Bishop (Experiments **5**, etc.) **1.95**

41–155 **HEAVY WALLED BAROMETER TUBE,** heavy walled glass tube 80 centimeters long, closed at one end . . . . . **.28**

41–157 ——, graduated, for use when quantitative measurements are desired. This tube is graduated throughout the entire length to millimeters from zero at the open end of the tube **2.00**

41–160 **GILLEY IMPROVED FORM MERCURY WELL** . . . . . **.22**

AIR PUMPS

VACUUM PUMPS COMPRESSORS ASPIRATORS

THE RITCHIE PUMPS
Nos. 42–10 and 42–15

(See next page)

With the many vast improvements which have, in the past few years, been made in oil-sealed pumps, the question may reasonably be asked why we continue to make the Ritchie Pumps.

The answer is clear when we consider that the most minute details of construction have been worked out through years of experience and the manufacturer is, therefore, no longer in doubt as to the correct weight and kind of material to use in the valve and other essential parts, the form of the valve seat and method of grinding which will give the best results. Such matters of detail as the fitting of the plunger, the grinding of all internal parts, and a multitude of other points which must be carefully worked out in order to make sure that a pump will give permanent satisfaction, have been reduced to definite manufacturing terms, with the result that we are able to produce, at a definite price, an instrument in which we can guarantee a high degree of efficiency.

Considering all the conditions, we believe we are justified in claiming that the Ritchie type of pump is worthy of your most careful consideration. Please note that it **requires less attention** in use; that it gives a sufficiently **high degree of vacuum** for all practical laboratory purposes; that it may be absolutely relied upon and that no experience nor special precautions are required in its use.

THE INSTITUTE OIL-SEALED HIGH VACUUM PUMPS
Nos. 42–20 and 42–25

(See next page)

For work requiring the highest vacuum, the oil-sealed pump has been very generally recognized. The defects as well as the strong points of the old form of oil pump have been very carefully studied during the past two years, with the result that we are able to offer a pump in which the defects of the older pumps have been entirely eliminated. Our new type is rapid in action and guaranteed not to squirt oil from the cylinder. This latter difficulty has been common heretofore in practically all of the oil pumps on the market. Our pump is also capable of an extraordinarily high degree of vacuum.

TESTS. The test which we have found most practical is the electrical discharge in the exhausted chamber, and no pump passes our inspection department until it has produced a satisfactory X-Ray vacuum.

OPERATION. The operating part consists of a substantial metal cylinder alternately raised and lowered into a fluid chamber filled with oil of the lowest possible vapor tension. This action results in a Torricellian vacuum being produced in the cylinder at each stroke. At the proper place in the stroke the air is allowed to flow from the chamber being exhausted into the cylinder, and the operation is thus continued.

It will be noted that we obtain in a single cylinder all the advantages of two cylinders in tandem frequently used by manufacturers of oil pumps. This is made possible from the fact that air taken from the lower side of the cylinder to produce the Torricellian vacuum in the lower chamber is forced into the upper chamber, from which it is in turn expelled, a Torricellian vacuum being formed in the upper portion of the chamber.

It will thus be seen that the degree of vacuum depends upon the vapor tension of the fluid used.

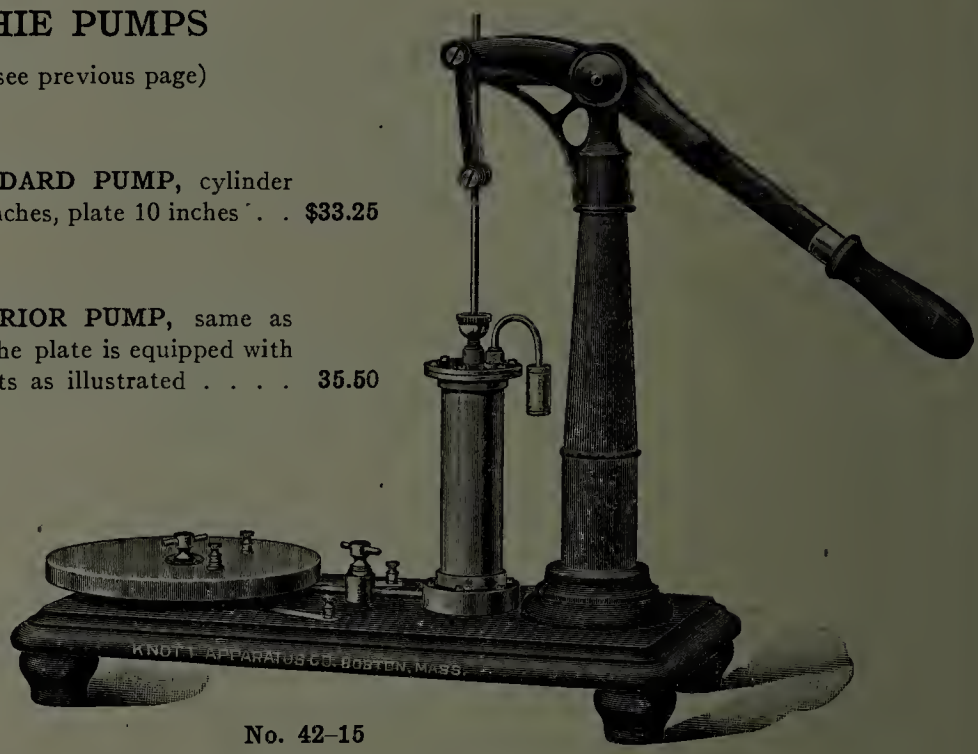
CONSTRUCTION. The simplicity of design enables all parts to be of most substantial construction. The absence of delicate valves to become worn and thrown out of adjustment insures the continued operation of the pump and its dependable qualities.

THE RITCHIE PUMPS

(For description see previous page)

42–10 **THE RITCHIE STANDARD PUMP,** cylinder 2¼ inches, stroke 7 inches, plate 10 inches . . **$33.25**

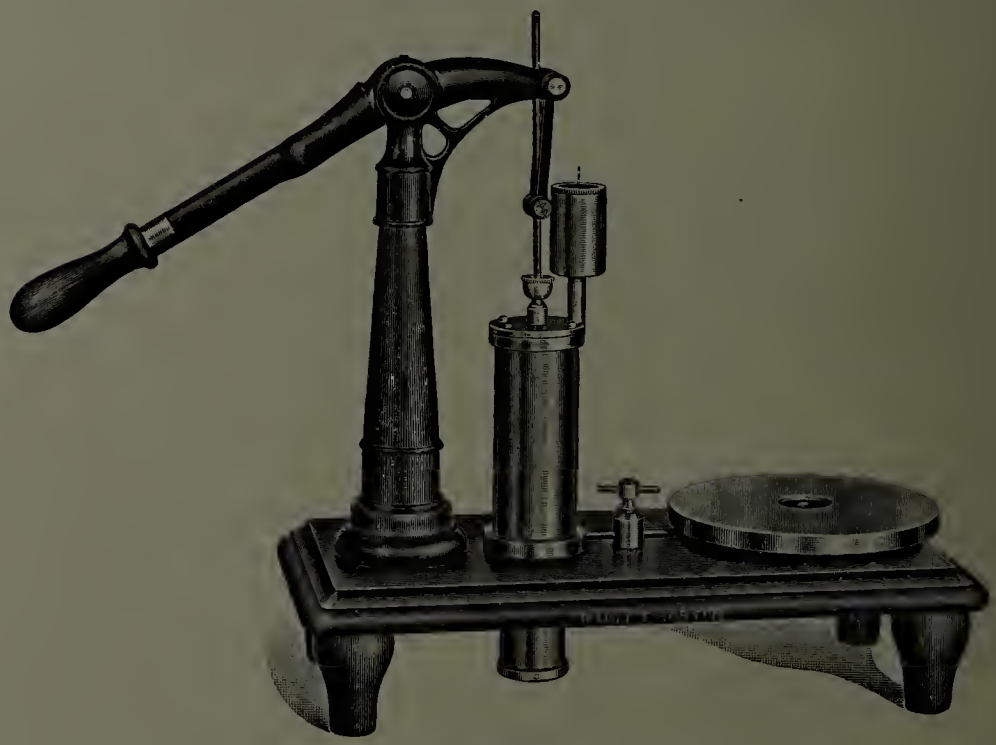
42–15 **THE RITCHIE SUPERIOR PUMP,** same as above, except that the plate is equipped with insulated binding posts as illustrated **35.50**



No. 42–15

THE INSTITUTE OIL-SEALED PUMPS

(For description see previous page)



No. 42–20

42–20 **INSTITUTE OIL-SEALED PUMP "A,"** cylinder 2⅛ inches, stroke 5 inches, plate 10 inches . . **$26.80**

42–25 **INSTITUTE OIL-SEALED PUMP "B,"** cylinder 2½ inches, stroke 8 inches, plate 10 inches . . **45.00**

42–45 **TORRENTIUM OIL FOR HIGH VACUUM WORK.** For the best results with oil-sealed pumps, especially prepared oil having both the right viscosity and vapor tension is required. To meet the requirements of our own Institute Pumps as well as for all oil-sealed pumps, we have arranged to have supplied to us a special oil prepared to meet the most exacting demands of high vacuum work.

The price is of necessity somewhat higher than for oils of commercial grade, but the amount required for each pump is so small that the expense is nominal . . . . . Per Quart **1.25**

No. 42-75

No. 42-82

42-75 CONDENSING AND EXHAUSTING HAND AIR PUMP WITH SWIVEL for general utility in laboratory practise where a relatively low vacuum or pressure is desired.

This is a simple pump with valve for both compression and exhaustion and has a cylinder 1 inch in diameter by 11½ inch stroke. The lower end is drilled and tapped to receive our air pump attachment which, in use, requires No. **5-1000** Universal T-beam Basic Clamp "A." This pump attachment is made in two parts and held together by a friction joint which allows the setting of the pump to any angle in one plane. It is provided with a nickel-plated T-screw for securing to the Basic Clamp.

Complete as illustrated, without Basic Clamp **$4.00**

42-76 ——, similar to above, but with attached Clamp **3.60**

42-80 AIR PUMP PLATE, diameter 10 inches, vent hole tapped for all air pump accessories, surface turned true and carefully ground plane. Mounted on substantial tripod base and provided with guard plug and stop-cock **4.90**

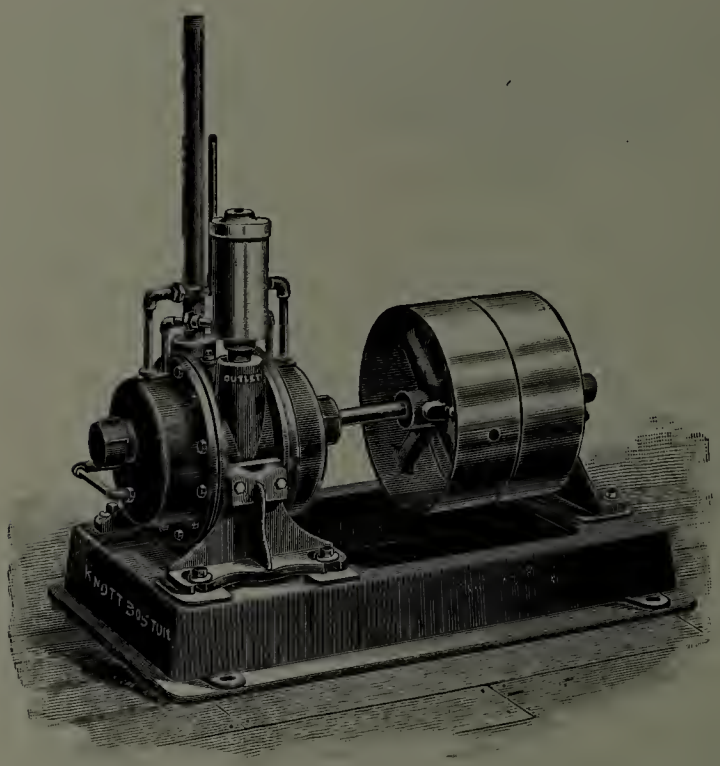
42-82 TEN-INCH HEAVY GROUND GLASS PUMP PLATE. The plate consists of ground glass plate which is firmly cemented to a low form of special tripod base. The base is cast in one piece to obviate danger of leakage. It is provided with brass stop-cock and brass connecting tube with oil-sealed taps for inlet of air, and manometer **$9.35**

42-100 BOLTWOOD MERCURY PUMP, an inexpensive automatic mercury pump requiring only a small amount of mercury. This pump is practically automatic in its action and is continuously operated by a small aspirator. It is rapid in action and will exhaust a liter flask sufficient for any ordinary work in twenty minutes.

Mounted on neat wooden stand **11.25**

42-102 ——, same as above, without stand **9.00**

No. 42-100



No. 42–110

42–110 ROTARY COMPRESSOR OR VACUUM PUMP, capacity 15 cubic inches per revolution. Pulleys, 6 inches in diameter, 2-inch face.

The idea of these rotary pumps is comparatively new, and, from their construction, are designed to fulfil all the usual requirements of a compressor or a vacuum pump. For many purposes they are unexcelled. Besides presenting a mechanical and handsome appearance, these pumps have the following features which are highly recommended.

The in-take and delivery of air is continuous and does not depend upon valves or springs of any form.

The simplicity and facility with which they may be set up and operated.

The small floor space and the light power required.

The positive lubrication secured by simple automatic lubricator.

The efficient cooling by special water jackets.

The high degree of efficiency possible:—a pressure capacity of 25 to 30 pounds per square inch when used as a compressor; as a vacuum pump, maintaining most any vacuum possible, under local conditions of the atmosphere, up to 90 per cent. **$55.00**

42–130 HARCOURT ELECTRIC COMPRESSED AIR OUTFIT. Consists of an electric air compressor connected to and mounted on same base as the storage tank.

The **Electric Air Compressor** runs from any 110-Volt socket A. C. or D. C., has no exposed electrical parts, gearing, chains, belts, rods, shafts or levers. Is guaranteed to develop 100 pounds air pressure without overheating.

Under actual laboratory tests this compressor filled the 5-gallon tank in four minutes with air at 60 pounds pressure, which pressure was increased to 70 pounds in five minutes, 80 pounds in six minutes and 90 pounds in seven and one-half minutes.

Current consumption 160 watts.

Storage Tank is a 5-gallon galvanized iron tank, guaranteed air-tight and provided with all necessary cocks and pressure gauge.

Complete as illustrated, with electric cord, and attachment plug **$69.50**

No. 42–130

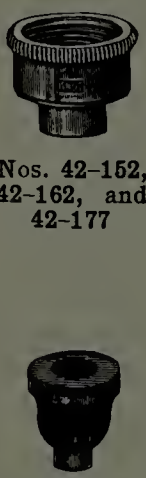
42–135 COMPRESSED AIR OUTFIT WITH HAND COMPRESSION PUMP. Similar in general structure to above, but with Compound Lever Compression Pump in place of the Electric Air Compressor.

Cylinder 3¼ inches, stroke 5½ inches, displacement per stroke 45.6 cubic inches, working pressure about one hundred pounds.

With this outfit pressures up to 40 pounds can be readily secured.

Pump, Tank with necessary cocks and Pressure Gauge all connected and mounted on substantial base **$35.00**

Nos. 42–150 and 42–160



Nos. 42–152, 42–162, and 42–177

Nos. 42–153, 42–163, and 42–178

No. 42–175

No. 42–190

42–150 **CHAPMAN'S ASPIRATOR** for reduction of air pressure by water aspiration. This aspirator is of brass, 4 inches long, ⅛ inch I. P. size thread, giving a capacity of 5 cubic feet per hour $1.45

42–152 **HYDRANT COUPLING** for use in connecting our No. **42–150** to ¾-inch hose faucet 30

42–153 **HYDRANT COUPLING** for connecting our No. **42–150** to a smooth faucet. These couplings cannot leak or be forced off 50

42–160 **CHAPMAN'S ASPIRATOR,** similar to No. **42–150,** but with capacity of 18 cubic feet per hour. Length 5 inches; ¼ inch I. P. size thread 1.95

42–162 **HYDRANT COUPLING** for use in connecting our No. **42–160** to ¾-inch hose faucet 30

42–163 **HYDRANT COUPLING** for use in connecting our No. **42–160** to a smooth faucet. These couplings cannot leak or be forced off 50

42–175 **RICHARD'S ASPIRATOR,** a more powerful and efficient filter pump than Nos. **42–150** and **42–160.** Length 7 inches; ⅜ inch I. P. size thread 1.80

42–177 **HYDRANT COUPLING** for use in connecting our No. **42–175** to ¾-inch hose faucet $0.30

42–178 **HYDRANT COUPLING** for use in connecting our No. **42–175** to a smooth faucet. These couplings cannot leak or be forced off . . .50

42–190 **MUENCKE'S ASPIRATOR,** entirely of glass, total length 8½ inches. As all parts are visible, this is a convenient demonstration instrument 1.00

42–200 **ASPIRATOR DEMONSTRATION TUBES** after Hall No. **XLVII.** Pair .65

HIGH PRESSURE AIR STORAGE TANKS for the storage of air or non-corrosive gases under pressure. These tanks are made of heavy galvanized iron and guaranteed to be absolutely air-tight, under a guarantee test of 150 pounds and for a working pressure of 100 pounds.

43–110 **AIR STORAGE TANK,** capacity 2½ gallons, size 6 inches diameter by 20 inches high 6.65

43–111 ——, capacity 5 gallons, size 9 inches diameter by 20 inches high . . 7.40

43–112 ——, capacity 12 gallons, size 10 inches diameter by 33 inches high . 8.90

PRESSURE GAUGE. See No. **41–60**

Nos. 43–110 to 43–112

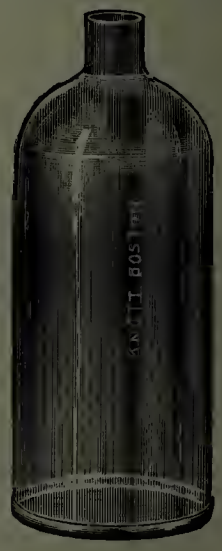
BELL GLASSES

CLEAR, WHITE GLASS, FLANGES GROUND AND TESTED

Nos. 43–25 to 43–27

Nos. 43–35 to 43–40

No. 43–50



No. 43–60

No. 43–80

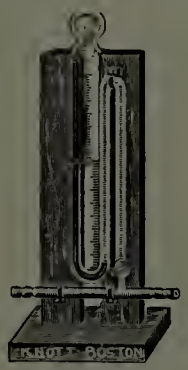
Nos. 43–65 to 43–67

No. 43–70

No. 43–75

43–25	**STRAIGHT FORM BELL GLASS, WITH KNOB TOP.** Capacity 1 gallon, inside height 11 inches, diameter 6 inches	$1.45
43–27	——, same as above, capacity 2 gallons, inside height 15 inches, diameter 7 inches	2.20
43–35	**SWELLED FORM BELL GLASS, WITH KNOB TOP.** Capacity 2 gallons, inside height 12 inches, diameter 7 inches	1.95
43–37	——, same as above, capacity 3 gallons, inside height 13 inches, diameter 8½ inches	2.90
43–40	——, same as above, capacity 5 gallons, inside height 15 inches, diameter 10 inches	6.30
43–50	**STRAIGHT FORM BELL GLASS, WITH GLASS STOPPER.** Capacity 1 gallon, inside height 11 inches, diameter 6 inches	1.75
43–60	**STRAIGHT FORM BELL GLASS, NECK FOR CORK STOPPER.** Capacity 1 gallon, inside height 11 inches, diameter 6½ inches	1.45
43–65	**LOW FORM BELL GLASS, WITH KNOB TOP.** Inside height 2¼ inches, diameter 4 inches	.65
43–67	——, same as above, inside height 4 inches, diameter 6 inches	1.00
43–70	**HAND AND BLADDER GLASS,** swelled form, both flanges ground and tested, medium size	1.00
43–75	**BELL GLASS,** special mold, ground flange, re-enforced neck for our No. **30** rubber stopper. Inside height 4 inches. This bell glass is used with a one-hole rubber stopper and a barometer tube to perform the experiment of No. **43–80**	1.25
43–80	**BELL GLASS,** straight sides, about 3 feet high, flange ground and tested for use with No. **41–155** Barometer Tube and No. **41-160** Well, to show successive diminution in pressure when placed on the plate of an air pump. Complete as illustrated, with Barometer Tube and Well	4.25
43–82	**BELL GLASS** only, of above	3.75

No. 43–140



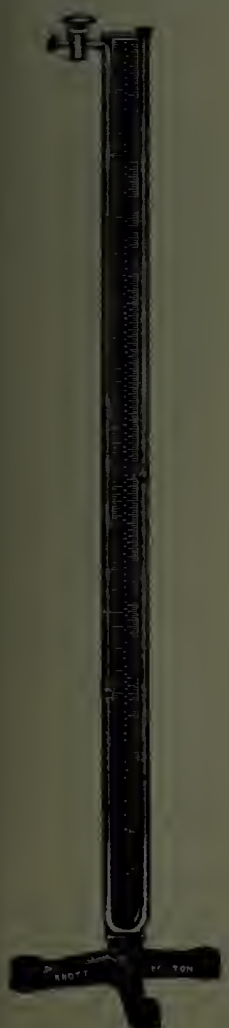
No. 43–145

No. 43–150

43–140 **MANOMETER** for attachment to air pump to denote degree of exhaustion.
This is an instrument carefully constructed and handsomely finished for attachment to the guard or vent hole to denote the degree of exhaustion. It consists of a metal casting, threaded to fit any hole threaded 7/16 by 16. Attached to this casting is a black oxidized metal scale filled in white, holding a manometer tube. This scale and tube are encased in a heavy glass cover.
This instrument will be found efficient, rapid, and a valuable accessory in the study of Pneumatics . **$5.45**

43–145 **MOVABLE SCALE MANOMETER,** mounted on neat wooden support stand, to determine the degree of exhaustion in experiments in Pneumatics.
This is an improved form of manometer with glass stop-cock which is mounted with a movable scale support supporting the mirror glass scale on a neatly finished wooden stand **6.25**

43–150 **SIMPLE MANOMETER,** consisting of a U-tube mounted with scale on a neatly finished wooden stand **1.70**



No. 41–113

43–160 **JAR WITH TWO MANOMETER TUBES, INLET TUBE and PINCH-COCK,** after Millikan, Gale and Bishop (Experiment 5) **$1.25**

43–161 **MANOMETER TUBE** only . . . . . **.40**

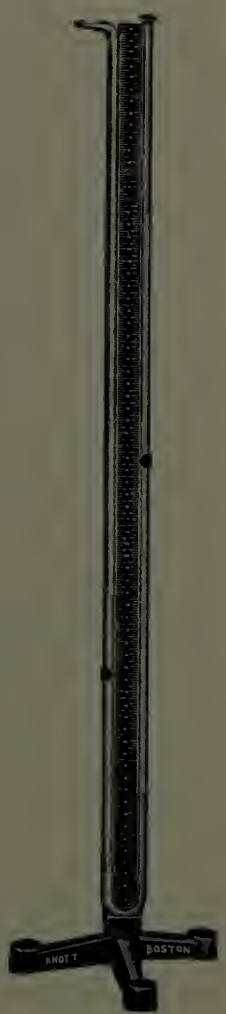
43–165 **BALANCING COLUMNS TUBE,** after Millikan, Gale and Bishop (Experiment 5) . . . . . **.85**

41–113 **MILLER'S COMBINATION PRESSURE GAUGE,** for registering high pressures.
This is a tube, 1 meter in height. Our illustration shows it mounted on our No. **41–116** Boyle's Law stand. One arm of this tube is provided with a stop-cock so that the instrument may be used as a Boyle's Law Tube as well as a barometer. In use as a pressure tube, however, this stop-cock must be left open. In use as a Barometer, the stop-cock is left open until the tube has been completely filled, when it is closed. The mercury will then fall to the point of barometric height. Complete as illustrated, with stand **3.85**

41–114 **MILLER'S COMBINATION PRESSURE GAUGE.** Tube only, unmounted **2.00**

43–170 **PRESSURE GAUGE,** as designed by Messrs. Turner and Hersey.
This gauge has been especially designed for registering high pressures, the length facilitating this use. It must be used, however, on some form of stand. Our illustration shows it in use mounted on our No. **41–116**, a description of which will be found under No. **41–115.**
Complete as illustrated, with stand **3.30**

43–171 **PRESSURE GAUGE.** Tube only, unmounted . **1.35**



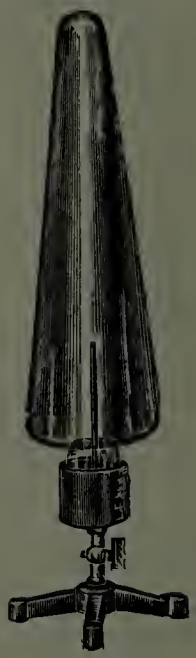
No. 43–170

No. 43–200

No. 43–202

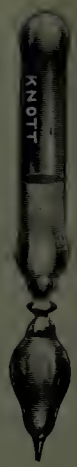
No. 43–204

No. 43–206

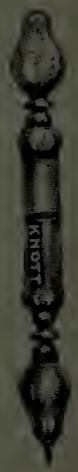


No. 43–240

No. 43–245



No. 43–247



No. 43–250

43–200 **BRASS COUPLING,** threaded to fit our air pumps and air pump accessories **$0.33**

43–202 **BRASS STOP-COCK,** double male screw, threaded to fit our air pumps and air pump accessories; ⅛ inch bore . . . . . **.55**

43–204 **BRASS NIPPLE,** female screw, threaded to fit No. **43–202** Stop-cock or No. **43–200** Coupling, or any of our air pumps and air pump accessories . . . . . **.33**

43–206 **BRASS GUARD PLUG,** threaded to fit our air pumps . . . . . **.33**

43–207 **BRASS T-GUARD PLUG** threaded to fit our air pumps . . . . . **.43**

43–210 **PUMP OIL AND CAN.** This combination will recommend itself to many teachers who require an efficient lubricator. Four-ounce size with screw stopper. Filled . . . . . **.35**

43–215 **PHOSPHORUS PENTOXIDE** for absorption of moisture in high-vacuum experiments. Sealed bottle, containing 1 ounce . . . . . **.65**

43–217 **VACUUM TUBING.** This is a specially prepared heavy-walled reinforced rubber tubing, 5/16 inch diameter, obviating leakage in making air-tight connections . . . . . Per Foot **.20**

43–220 **RUBBER DAM OR THIN RUBBER SHEETING,** especially useful in illustrating the crushing force of atmospheric pressure . . . . . Per Square Foot **.33**

43–221 **VEGETABLE PARCHMENT,** good quality, adapted for demonstrating the crushing force of atmospheric pressure . . . . . Per Sheet **.10**

43–222 **ANIMAL PARCHMENT,** good quality . . . . . Per Square Foot **.50**

43–225 **LEATHER WASHERS** for use with stop-cocks, plugs, etc., ¾ inch diameter by 7/16 inch hole. Per Dozen **.25**

43–230 **RUBBER BAG** for experiments in pneumatics. This bag is of light rubber of the best quality and is furnished complete with outlet tube and screw pinch-cock **1.15**

43–240 **FOUNTAIN IN VACUO,** illustrating atmospheric pressure. In use, the tripod is removed and the apparatus is screwed to the center of the pump plate. The stop-cock is then turned and air exhausted from the vessel. If the apparatus is again mounted on the tripod and placed in a dish of water the pressure of the atmosphere will force the water into the vessel showing a very vigorous fountain as soon as the stop-cock is opened.
Complete as illustrated **5.50**

43–245 **DEMONSTRATION SIXTEEN-INCH WATER HAMMER** for showing that water or any liquid will fall as a solid in a vacuum.
In use, the air is exhausted from the tube and the end held under water and stop-cock opened. Water is allowed to be forced by atmospheric pressure until about ¼ full. If tube is now inverted, the water will fall as a solid mass, the tube emitting a distinct sound as if struck by a blow **2.80**

43–247 **WATER HAMMER,** illustrating that water will fall as a solid in vacuo. This consists of a tube, 30 centimeters in length, partially filled with water in a vacuum. With one bulb . . . . . **.65**

43–250 **TWO-BULB MUSICAL WATER HAMMER,** arranged so that the water falling in vacuo will emit pleasing tones in addition to the metallic click **1.10**

No. 43–255

Nos. 43–276 and 43–277

No. 34–40

No. 43–270

43–255 MAGDEBURG HEMISPHERES for demonstrating atmospheric pressure in all directions.

The apparatus consists of two cast, hollow hemispheres of metal, the edges of which are carefully ground smooth to make an air-tight junction. On one is cast a "boss" which is tapped for a brass stop-cock threaded to fit the air pump and also the tripod illustrated. Each hemisphere is provided with convenient handles. The whole is durably and handsomely finished **$3.95**

34–40 SEVEN-IN-ONE APPARATUS OR SPIROMETER, GAGE'S IMPROVED for demonstrating fundamental principles in pneumatics and hydraulics.

This apparatus consists of a seamless brass cylinder 6 inches in diameter, mounted on a metal casting, provided with bosses, into which rods may be screwed from either side. The cylinder is provided with an ingeniously designed piston which, owing to its construction, has greater efficiency the longer the use. This construction also obviates the sticking of the washers and leakage around them. Each instrument is provided with our detachable handle in the piston head, a fixed handle with brass stop-cock with nipple, a rubber tube, and funnel. This apparatus, as implied from the name "Seven-in-One," will illustrate the principles involved in seven different instruments, as follows: — Hydraulic Lift, Hydraulic Press, Incompressibility of Liquids Apparatus, Pascal's Law Apparatus, Pneumatic Lift, Hydrostatic Bellows, Magdeburg Hemispheres.

This instrument is handsomely finished in nickel plate and is furnished complete with three nickel-plated rods **8.90**

43–270 MODEL OF A DIVING BELL, demonstrating how, in a caisson, air is supplied to keep up life and to keep back the water.

The design above illustrated demonstrates, in a simple way, the principle of caissons. A conical-shaped glass vessel with meta mountings top and bottom has, at its top, a tube for supply of air which is forced into the vessel by means of an air pump. The bottom casting is designed to hold a slow-match as well as to support a weight. The whole is submerged in a jar of water as illustrated. The supply of fresh air through the tube keeps the spark on the slow-match alive. The whole is suspended in the jar by any convenient means.

Diving Bell complete with weight, slow-match and special jar **6.75**

43–276 BURSTING SQUARES. When placed under a bell glass on a pump plate and the air exhausted from under the bell glass the expansive force of the air in the bursting square will burst the square with great violence. (See Protecting Shield No. **43–277**) . . . . . Per Dozen **2.15**

43–277 WIRE GUARD for use under a bell glass to protect the bell glass from flying broken parts of the bursting squares . . . . . Each **.45**

No. 43–280

No. 43–285

No. 43–290

43–280 BELL IN VACUO APPARATUS, illustrating non-transmission of sound in a vacuum.

This apparatus consists of a large-sized bell jar with brass cap, through the center of which slides a brass rod gripped air-tight by means of a packing screw. A bell suspended by a horizontal axis in a stirrup is supported over the vent in the center of the pump plate. This bell is rung by tipping through the agency of the sliding rod.

When placed on pump plate, as illustrated, if air is not exhausted, the bell, if tipped, will emit a distinct tone. If, however, the air is exhausted, the sound, though not absolutely lost, will be diminished to such an extent as to readily illustrate the non-transmission of sound in a vacuum.

Complete as illustrated, with Bell and Stirrup and Bell Glass with Sliding Rod. All brass parts polished and lacquered **$6.80**

43–282 BELL IN STIRRUP, as illustrated above **2.80**

43–283 BELL GLASS WITH SLIDING ROD, as illustrated above **4.00**

43–285 BELL IN VACUO, illustrating non-transmission of sound in a vacuum.

This is a self-contained instrument supplied with a small nickel-plated bell suspended by springs to brass binding posts which are sealed into the top of a medium-sized bell glass. As the flange of this bell glass is carefully ground and tested and the vibration of the bell is deadened by suspending on springs, the non-transmission of sound is quite noticeable, the tone being almost lost in the vacuum.

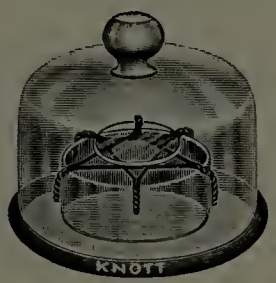
Complete as illustrated **2.90**

43–290 MOUNTED ELECTRIC BELL for use in connection with a bell glass and with our No. **42–15** Air Pump with electrical connections, to illustrate non-transmission of sound in a vacuum

Mounted as illustrated on neatly polished wooden upright **1.60**

43–25 BELL GLASS, straight form, with knob top, 11 inches high by 6 inches diameter **1.45**

No. 40–22



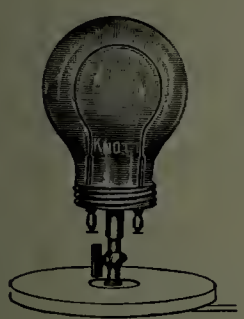
No. 43–310

40–22 BELL IN BAROSCOPE GLOBE for the illustration of non-transmission of sound in a vacuum; also used to demonstrate the fact that air has weight.

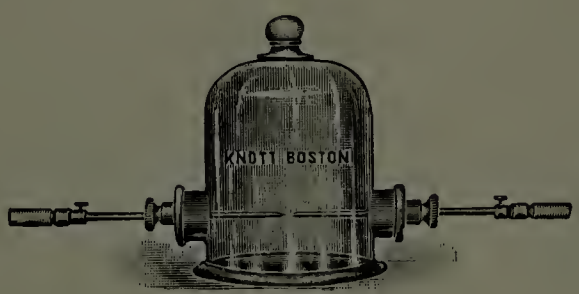
This is a glass globe, 4¼ inches in diameter, fitted with brass cap and a stop-cock with hook, and has in its interior a small bell.

To demonstrate that air has weight, this globe is used as an ordinary baroscope globe; to illustrate non-transmission of sound, shaking the globe before and after exhaustion shows that the tinkling of the bell is not heard, or heard only dimly, when the globe is in exhausted state **$5.40**

43–310 FREEZING APPARATUS, illustrating freezing by the rapid evaporation of ether or other volatile liquids. **1.40**



No. 43–315



No. 43–325

43–315 DEMONSTRATION NITROGEN FILLED INCANDESCENT LAMP. A heavy glass globe fitted with metal cap and stop-cock, the end of which is threaded to fit the air pump. Binding posts are hermetically sealed and are connected directly to the filament holders. Arranged so that it may be filled with nitrogen to demonstrate nitrogen filled lamps. Complete with one-half dozen special filaments **$3.50**

43–317 DEMONSTRATION INCANDESCENT LAMP FILAMENTS for use with above . Per Dozen **.17**

43–325 DEMONSTRATION ARC LAMP for illustrating passage of electric current through rarefied gases.

This apparatus consists of a bell glass with two lateral openings with brass caps, through the center of which pass the sliding rod carbon holders held in sliding grips by packing screws. These sliding rods are terminated by hard rubber handles and are provided with binding screws for attachment of electric current. As the bell glass is 10 inches in diameter, a pump plate of that size must be used with this instrument.

This apparatus is carefully made and the experiment, if properly conducted, is exceedingly instructive and the results spectacular.

Complete with extra pair of carbon pencils . . . . . Duty Free **14.65**

43–326 CARBON PENCILS for use with above . . . . . Per Dozen **1.75**

BAROMETERS

The value of the Weather Bureau Type of Barometer has been realized in no small degree because of the large reservoir in which the height of the mercury is adjusted by means of the screw plunger at the bottom, the correct zero being indicated by a pearl white pointer projecting downward towards the surface of the mercury. This indicator being fixed, and the scale rigidly attached with reference to it, the level of the mercury is readily brought to the correct zero point before each reading. Many other methods of adjustment have been devised, but none have even approached this for accuracy and ease of operation.

No. 45–15

45–10 FORTIN SCHOOL BAROMETER, with cistern and method of adjustment, same as described above.

SCALE in both English and Metric systems with clearly indicated divisions.

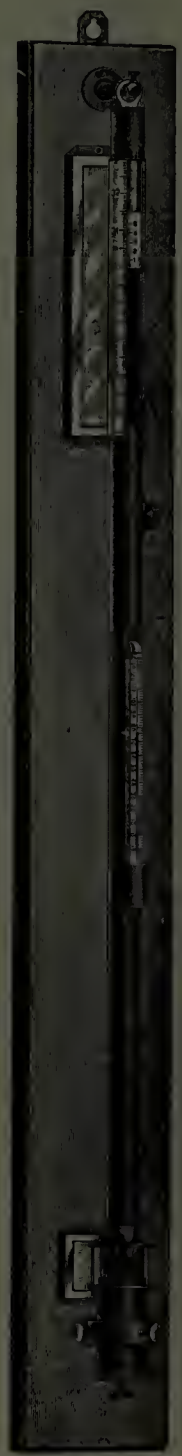
TUBE of generous proportions filled with greatest care.

MOUNTING, well seasoned hardwood with rosewood finish, and protecting cap over the reservoir to prevent breakage, so designed as to permit clear view of both pointer and mercury in the reservoir **$9.85**

45–15 FORTIN CISTERN SCHOOL BAROMETER WITH VERNIER, double scale, double vernier, and thermometer. Scale reads from 24 to 32 inches with equivalent metric scale, reading with vernier to $\frac{1}{10}$ millimeter or $\frac{1}{100}$ inch **16.80**

45–20 WEATHER BUREAU FORTIN BAROMETER, with extra large mercury tube, cylindrical bulb mounted in oxidized brass, with insulating support and binding screws, thermometer with graduated stem scale, a thoroughly high grade instrument of a type used in all Weather Bureau Stations . . **40.00**

45–25 MOUNTING BOARD of mahogany, rosewood finish, supporting arm with locknut, dead white plate back of scale and mercury cistern, provided with screws for supporting in a vertical position **4.85**



No. 45–20

No. 45–30

No. 45–40

45–30 DEMONSTRATION ANEROID BAROMETER, desirable for the explanation and illustration of the mechanism of the ordinary Aneroid Barometer.

This instrument is ample in size for lecture room use and is particularly adapted to such use in that all parts are uncovered and can be distinctly viewed through a glass dome. Parts mounted on a polished hardwood base. Vacuum chamber connected with a length of rubber tubing which can be connected to small capacity air pump or demonstrated more simply by blowing in or drawing out the air through the mouth. The varying pressure is readily shown by means of the indicating hand over the scale.

This instrument is a beautiful ornament and its construction is accurate enough for barometric observations $18.25

45–40 ANEROID BAROMETER, adjusted for altitudes up to 3,500 feet, improved form, 4 inches in diameter, mechanism mounted in highly polished and nickel-plated brass case. Dial open that mechanism may be in full view. Graduations read in both the English and the Metric system 4.25

No. 45–50

45–50 ANEROID BAROMETER, adjusted for altitudes up to 3,500 feet, brass case with closed silvered-metal dial 5 inches in diameter.

This barometer is improved by a patent altitude adjustment which consists of an auxiliary hand. This hand is adjustably attached to the pressure hand and moves with it. While the pressure hand shows the actual atmospheric pressure at the altitude at which the Aneroid is used, the patent adjustment hand may be so regulated as to show also the corresponding sea-level pressure . . . . . Each 8.00

45–55 HIGH ALTITUDE ANEROID BAROMETER. The movements of this barometer are of good quality and in their general construction are identical to those illustrated in No. **45–40**; adjusted for use between 4,900 and 9,500 feet. Mechanism enclosed in polished brass case and open porcelain dial so that mechanism is in full view 10.25

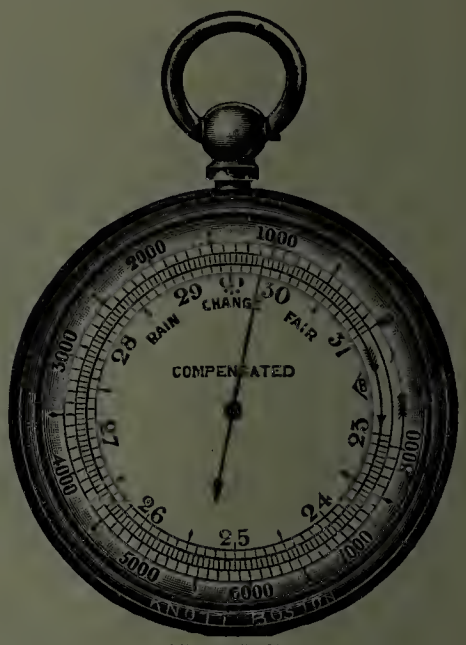
45–57 ——, same as above, but of special design, most careful construction, and compensated for changes in temperature. Adjusted for use between 5,950 feet and 11,800 feet. Mechanism enclosed in polished brass case with open silvered metal dial. Mechanism in full view . . 17.25

45–65 POCKET MOUNTAIN ANEROID BAROMETER, watch case form. This is a highest quality Aneroid, 1¾ inches in diameter, compensated for temperature, silvered-metal dial, revolving altitude scale. Enclosed in polished brass case. Adjusted to read to 3,000 feet. Enclosed in neat morocco, plush-lined case $16.00

45–67 ——. same as above, but adjusted to read to 8,000 feet . . 17.25

45–69 ——, same as above, but adjusted to read to 10,000 feet . 18.50

45–71 ——, same as above, but adjusted to read to 16,000 feet . 19.75



No. 45–67

No. 45–100

45–100 RECORDING BAROMETER (BAROGRAPH). Barographs are instruments arranged to record upon a chart all atmospheric changes in pressure, the amount of rise and fall of same, and the time such changes occurred. The mechanism of the ordinary barograph consists of a "pile" or series of vacuum chambers each secured to the other above and below making a greatly magnified sensitive movement. This movement is further magnified and transmitted to an aluminum recording arm carrying a pen by a series of connecting levers. This pen records the changes in pressure on a chart which encircles a drum containing a clock movement. As this clock revolves once in seven days, a week's record can be obtained on the chart. As the top of the chart is divided into seven spaces, each allotted for one day a week and sub-divided into spaces representing two hours, it is possible to tell at what time of any day the atmospheric pressure underwent a change. This week's record will be in the form of a tracing along the chart. By referring to the top of the chart it may be noted at what day and hour a rise or fall of pressure occurred.

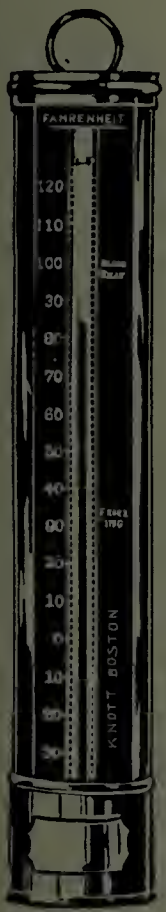
A Barograph, then, is the most reliable form of a barometer and has the further feature that observations are recorded, whereas in weather prognostications a single observation of the barometer is of little or no value.

The instrument listed above has for years been the standard for meteorological work, and its quality in all particulars is unquestioned. In addition to a careful and accurate fitting and adjusting of parts this instrument is handsome in appearance and will be found exceedingly valuable in any laboratory. Enclosed in mahogany frame glass case cover.

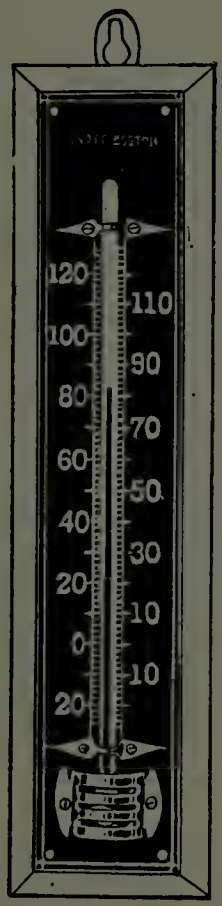
Complete, with one year's supply of charts $36.75

45–102 BAROGRAPH CHARTS as used in above instrument. Box containing one year's supply 2 50

METEOROLOGICAL THERMOMETERS

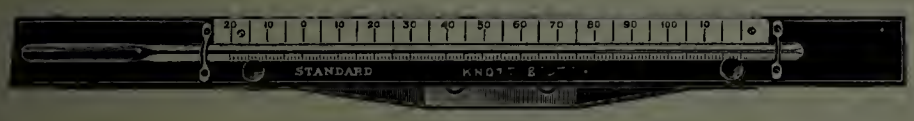


No. 63–10



No. 63–12

No. 46–35



No. 46–30

63–10 **HOUSEHOLD THERMOMETER,** 8 inches long, heavy metal frame, black metal scale with white figures, reading from −30° to 120° F. **$0.60**

63–12 **HOUSEHOLD THERMOMETER,** 10 inches long, metal scale on hardwood back, reading from −30° to 120° F. . . . . **.95**

46–30 **WEATHER BUREAU PATTERN THERMOMETER WITH CERTIFICATE,** engraved stem, magnifying mercury tube, cylindrical bulb, porcelain strip at side of tube in which are marked the figures and every fifth degree line of the scale, oxidized black plate, insulating brass support with binding screws. Scale range 40° below zero to 120° F. above **5.45**

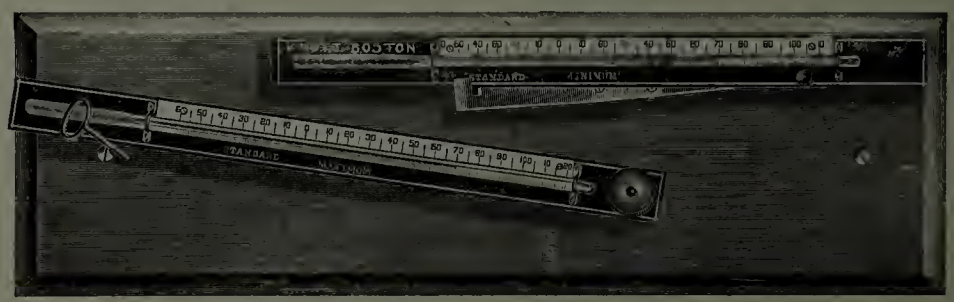
46–35 **SIX'S MAXIMUM AND MINIMUM SELF-REGISTERING THERMOMETER,** black oxidized brass scales, white filled figures, japanned tin case, length 8 inches, scale range 10° to 40° below zero to 120° F. above. Enclosed in box **3.35**

THERMOMETRIC CONVERSION FACTORS

$F = 9/5\ C+32$
$C = 5/9\ (F-32)$
$R = 4/9\ (F-32)$

$F = 9/4\ R+32$
$C = 5/4\ R$
$R = 4/5\ C$

No. 46–40



No. 46–52

No. 46–70

46–40 MAXIMUM AND MINIMUM THERMOMETERS, medium grade thermometers with magnifying tubes and black oxidized brass scales, each tube 10 inches long, mounted on a separate plate attached at one end with a thumb screw to the oak back so that the thermometers may be reset as illustrated above **$3.90**

46–50 WEATHER BUREAU MAXIMUM SELF-REGISTERING THERMOMETER, scale range 40° below zero to 120° F. above.

This thermometer has an engraved stem, magnifying tube, cylindrical bulb, porcelain strip at side of tube on which are marked the figures and every fifth degree line of the scale. It is mounted on an oxidized brass plate with insulating brass support with binding screws. Each thermometer is 12 inches long and is furnished with a certificate of accuracy.

Enclosed in box **6.35**

46–51 WEATHER BUREAU MINIMUM SELF-REGISTERING THERMOMETER, as above described, range 20 to 60° below zero to 120° F. above. Each thermometer is 12 inches long and is furnished with a certificate of accuracy.

Enclosed in box **5.85**

46–52 WEATHER BUREAU MAXIMUM AND MINIMUM SELF-REGISTERING SET. This outfit consists of the Maximum and Minimum Thermometers above, appropriately mounted on a polished mahogany board 17 inches long by 5 inches wide. Each thermometer is furnished with a certificate of accuracy.

The whole, enclosed in a neat box **12.00**

46–70 SOIL THERMOMETER, 16-inch wood frame with handle, brass pointed ferrule, glass cylinder, hand written paper scale **1.40**

No. 46–110

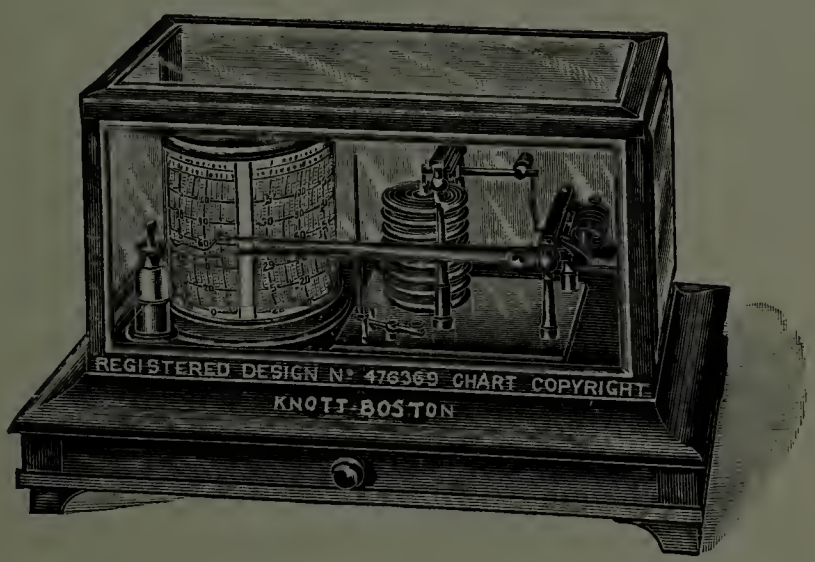
46–110 RECORDING THERMOMETER (THERMOGRAPH). What has been said of the advantages of the use of a barograph may just as consistently be repeated regarding the advantages of the use of the thermograph. The continuous record of temperature changes is necessary in any intensive study of Meteorology.

Our line of Thermographs consists of bi-metallic lamina arranged in such a manner that there are no levers other than the pen arm used in its construction. This construction insures rigidity, overcoming all lag or creep and friction, and in consequence is much more sensitive to slight changes in temperature than the standard mercurial thermometer.

This instrument is an 8-day cylinder clock, low drum type, chart showing range from 30° below to 110° F. above. Movement enclosed in a hinged metal case with padlock. This case is supplied with glass window, well ventilated, and with leather handle for carrying.

Complete with one year's supply of charts **$36.75**

46–112 THERMOGRAPH CHARTS, as used in above instrument. Box containing one year's supply . . **2.50**



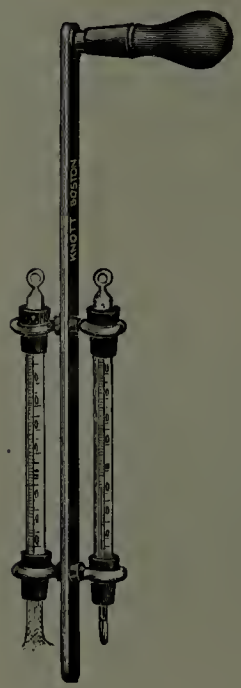
No. 46–120

46–120 BARO-THERMO RECORDER (COMBINED THERMOGRAPH AND BAROGRAPH). The above illustration pictures a recent improvement which has been introduced in recording instruments by combining the Barograph and the Thermograph in the same instrument. The records are given on the same chart, but in different colored inks to prevent confusion (blue for the Barograph and green for the Thermograph).

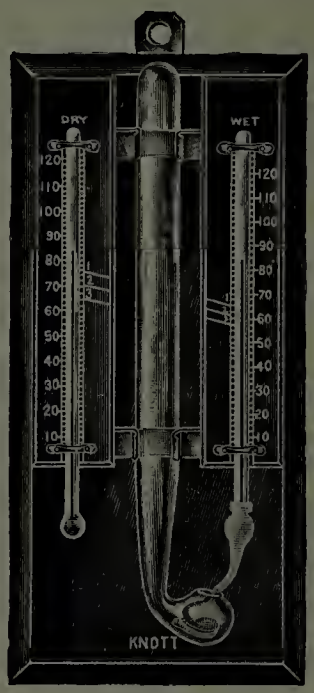
Baro-Thermo Recorder **$60.00**

46–122 BARO-THERMO RECORDER CHARTS, one year's supply, for use with above **2.75**

HUMIDITY INDICATORS AND RECORDERS



No. 47–10



No. 47–15

No. 47–20

47–10 **"SLING" PSYCHROMETER OR HYGROMETER** for obtaining quick and more accurate results than are possible with the stationary wet and dry bulb instruments.

This instrument consists of two accurate thermometers firmly attached to a metal arm swiveled to a wood handle. In use one of these bulbs is covered with a wicking which should be thoroughly saturated with water. To obtain readings, whirl the instrument fifteen or twenty seconds, holding it well away from the body. Stop and note the wet bulb temperature; continue the operation, whirling and reading until two readings of the wet bulb thermometer are obtained alike or nearly so. This will be the lowest temperature. Tables and full directions are supplied with the instrument to determine the per cent. of relative humidity . . . . . Each **$2.50**

47–15 **MASON'S HYGROMETER** (Wet and Dry Bulb), good quality, magnifying mercury tube, silvered brass scales with black filled figures and graduations, mounted on polished oak board 11 × 5 inches. Enclosed in a box **3.35**

47–20 **WEATHER BUREAU PATTERN HYGROMETER** (Wet and Dry Bulb), consisting of two No. **46–30** Standard Thermometers mounted on a polished mahogany board 17 × 5 inches with nickel-plated brass cistern and silk wick.

This instrument is the United States Standard and may be depended upon for the utmost accuracy.

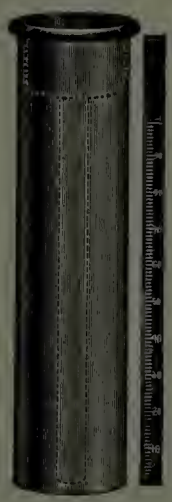
Each thermometer is supplied with a certificate of correction. Enclosed in box **$11.80**

No. 47–25

47–25 **SPIRAL HYGROMETER,** 80 millimeters diameter.

This simple little instrument, with handsomely nickeled case, is provided with a scale denoting the humidity of the air without reference to tables **2.00**

No. 47–40



No. 47–65

No. 47–75

47–40 DIRECT READING HUMIDITY APPARATUS (HYGROPHANT), a simple, convenient, and efficient means of determining both the temperature and humidity of the air with accuracy and without computation.

This instrument is provided with two standard thermometers, one showing the temperature of the air, the other the temperature due to evaporation. A cylinder upon which is inscribed a series of columns of figures numbered at their headings from 1 to 22 may be noted between the thermometers. These strips represent the difference in degrees between the indications of the thermometers and the columns exhibiting relative humidity or percentage of moisture in the air for every degree of temperature indicated by the thermometer. A fixed scale upon the casing in which the cylinder revolves indicates the relative humidity or percentage of moisture in the air.

In use the cup is filled with pure water into which dips the wicking attached to the wet bulb thermometer. As soon as this wicking and gauze which covers bulb become wet the instrument is ready for use. In ascertaining the actual temperature, read the indication of the thermometer on the right of the instrument; in ascertaining the temperature due to evaporation read the indications of the wet bulb thermometer. Now note the difference in number of degrees between the two thermometers. Turn the cylinder by means of the knob on the top so as to present to view the column of figures having at its head the number corresponding to this difference. In line then with the division on the fixed scale which corresponds to the degree indicated by the wet bulb thermometer, may be read the relative humidity or percentage of moisture in the air.

Complete with full and explicit directions for use $9.60

47–65 RAIN GAUGE, United States Weather Bureau type, diameter 3 inches, height 13 inches, with overflow and measuring stick 2.75

47–75 REGISTERING RAIN GAUGE. The rain gauge illustrated above is a pattern which is known as the "tilting bucket" gauge. No measurement is necessary as the rain is collected in the 8-inch receiver and is taken through a small pipe and dropped into one side of a bucket. When a given amount of rain has collected in the bucket (0.01 inch) the weight of the rain on the laden side causes it to overbalance, and by a mechanical arrangement the hand moves 0.01 inch at each operation.

The rain still passing through the receiver is collected in the opposite bucket. When that has received the given amount the same operation is repeated. The great advantage of this type of gauge is that it is zero set and is particularly useful when a person wants to keep a record of rainfall by the month or week. The dial registers one inch by 0.01 inch; the second or smaller dial reads upwards of 12 inches.

Enclosed in metal case 10 × 8 inches 24.75

No. 48–12

No. 48–30

No. 48–17

48–10 ANEMOMETER for measuring air currents through tunnels, mines, ventilators of public buildings, etc. The indications are obtained by means of a delicately poised fan wheel, the recordings being started by the long hand which traverses the outer circumference of the main dial which indicates a passage of 100 feet of air. This recording is continued up to 10,000,000 feet by a series of smaller dials, six in number. The disconnector projecting from the band of the instrument opposite the fan wheel serves to throw the mechanism out of gear, arresting its action when required.

In use the instrument is placed in the current in a number of different positions. Take the number of feet that have passed during a certain time, for example one minute, divide the total by the number of readings and obtain the average. Multiply this average by the square of the opening and the result is the velocity of air in feet passing in a given time.

Each instrument is enclosed with zero setting attachment in a neat mahogany case **$24.75**

48–12 ——, same as above, but with four dials reading to 100,000 feet. This instrument is recommended in preference to above in that the parts are not so delicate **24.75**

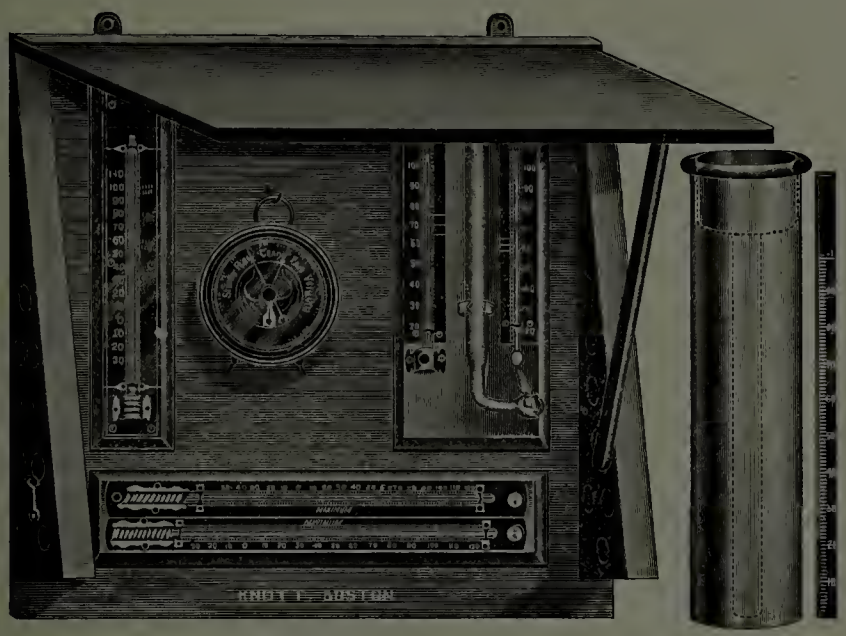
48–15 BIRAM'S ANEMOMETER for similar use as No. **48–10.** In this type of instrument the revolutions are recorded on a dial in the center of the instrument. Each instrument is tested and furnished with a chart of corrections, supplied with patent zero setting attachment in neat mahogany box, diameter 3 inches, two dials reading to 1,000 feet. This instrument will stand a pressure of 1,000 feet per minute **22.60**

48–17 ——, similar to above, 4 inches in diameter with four dials reading to 100,000 feet; will stand pressure of 3,000 feet per minute **23.80**

48–30 REGISTERING ANEMOMETER. This simple device for indicating the velocity of the wind in miles consists of a vertical shaft, to the upper end of which are fastened four arms, each carrying a Robinson hemispherical copper cup. These cups turn in one direction, regardless of the direction of the wind, and at a ratio determined by experiment. To the lower end of the shaft is fastened an endless screw which, as the shaft revolves, actuates a wheel which in turn meshes into a series of other wheels; thus the miles are indicated on the registering dial. The dial is so arranged as to show velocities from one-tenth of a mile to 10,000 miles, and then it repeats, commencing at zero.

To ascertain the rate in miles per hour at which the wind is traveling, make two readings with an interval of ten minutes and multiply the difference by six.

This instrument is carefully made and requires but little attention. All parts are interchangeable . **30.00**



No. 48–100

48–100 **HARCOURT STUDENTS' METEOROLOGICAL EQUIPMENT.** This is a complete set of Meteorological instruments of standard quality suitable for all work. The set must not be confused with various types on the market inasmuch as our set comprises standard instruments of medium quality. The set consists of the following, — one 10-inch Thermometer, metal scale on hardwood back; one 10-inch Maximum and Minimum Thermometer, mounted on hardwood back; one Mason's Hygrometer, mounted on polished oak board 11 × 5 inches; one 4-inch Aneroid Barometer, open dial, graduations both English and Metric systems, and one 3-inch U. S. Weather Bureau Rain Gauge with Measuring Stick.

The various instruments cited above, with the exception of the Rain Gauge, may be mounted within the Instrument Shelter as illustrated. This Instrument Shelter is of substantial structure, painted inside and out with a durable coat of lead paint. It is provided with brackets for attachment to wall.

Instrument Shelter complete as illustrated, with all instruments, including Rain Gauge **$15.25**

48–102 ——, as above illustrated, but without Rain Gauge **12.50**

INSTRUMENT SHELTERS

48–105 **INSTRUMENT SHELTER,** as above described in No. **48–100** but without instruments **$5.80**

48–115 **INSTRUMENT SHELTER.** Meteorology and climatology study in our schools has so come to the front during the last few years that it has become almost essential that a shelter for recording instruments be provided for outside use.

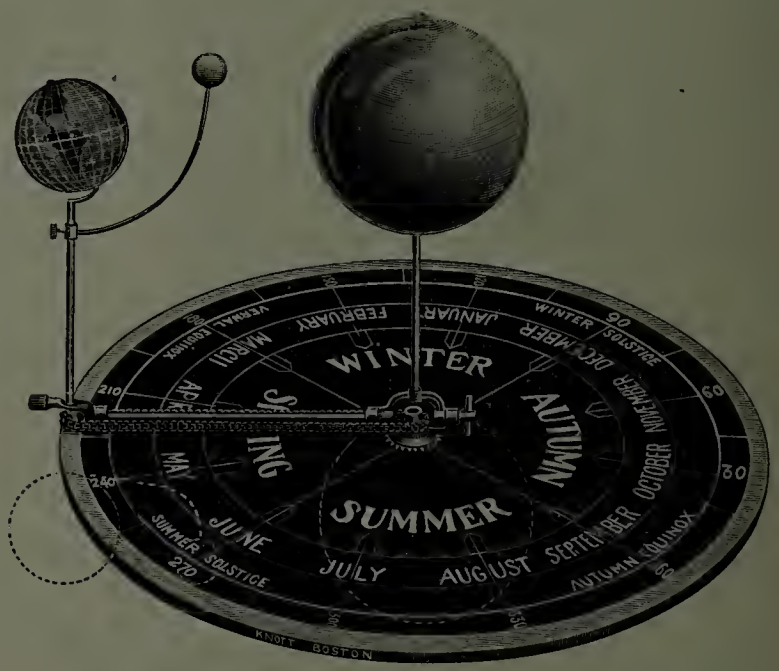
Our instrument is constructed after the latest pattern Weather Bureau Instrument Shelter and may be mounted on legs for use on the school grounds or attached to the side of a wall. It is sufficiently large to hold easily both a Barograph and Thermograph, a Hygrometer and a set of Maximum and Minimum Thermometers, an Aneroid Barometer and a Thermometer. It is constructed of the best quality straight-grained pine with swing door provided with lock and key. We secure perfect circulation of air and obstruction to rain by means of the blind construction usually employed in the manufacture of shelters. It is painted outside and in with a durable coat of lead paint.

Instrument Shelter, complete ready for mounting, but without instruments of any kind **20.00**

NO. 49-90

HACKELING TELLURIAN

Patent No. 858,977, Issued July 2, 1907



A simplified and improved form of Tellurian, invented by the late Dr. Hermann A. Hackeling. This instrument was designed with special reference to the needs of the instructor teaching Geography in the last year of the grammar school and the first year in high school, bearing in mind, also, its special usefulness in teaching Physical Geography and General Science in the first and second year of high school work.

To quote Dr. Hackeling's own words, his purpose was to "design an educational Tellurian which could be supplied to schools at a comparatively low price and which would make clear to the student the relative positions of the sun, earth, and moon, and the inter-relations resulting from their rotation and revolution."

Our designing department has given careful study to Dr. Hackeling's excellent design and has been able to improve upon it only to the extent of adapting the design to factory methods of production, thus insuring greater strength of working parts and, at the same time, making it possible to offer the instrument at a lower price.

As will be noted from the cut, all unnecessary features have been omitted and the essential parts have been simplified and strengthened. All mechanical parts are exposed to view, these parts being so simplified and strengthened as to insure the instrument not getting out of order.

Please note that in rotating the earth around the sun, the earth is at the same time given a positive and exact revolution, carrying with it the moon, the position of the moon with reference to the earth and the sun being varied by sliding vertically on the supporting rod.

Also note that the entire system, by loosening of the T-Screw, may be moved to a horizontal position, without changing the relation previously existing between the three bodies.

All metal parts are of substantial construction, well finished; the base being made of 5-ply, well seasoned hard wood, neatly finished.

This instrument has been pronounced by those who have given much study to this important feature of educational work, the only one which produces the desired results in a simple and direct way and so designed mechanically as to insure its not getting out of order.

$15.00

Special price will be quoted upon these in dozen lots, where it is desired to place the instrument directly in the hands of the student.

THE NEWELL COLLECTION

OF

LANTERN SLIDES IN CHEMISTRY

Selected and arranged by Lyman C. Newell, Ph.D., Professor of Chemistry, Boston University, Boston, Mass

The slides in this collection will be found of particular advantage in courses dealing with the historical side of Chemistry. There are 104 slides in the series, each slide, each subject most carefully selected. The series is particularly valuable in that it contains so many slides of eminent chemists, — American, Dutch, English, French, German and Italian, all of which are remarkably clear and distinct. The following subjects are stressed, — Alchemy, Atmosphere, Atomic Theory, Atomic Weights, Avogadro's Hypothesis, Combustion, Electro Chemistry, Elements, Metals, Halogens, and Chemistry in Eighteenth and Nineteenth Centuries.

Single Slides	Each	**$0.40**
Any 50 in Regular Lantern Slide Box		**20.00**

A descriptive circular free upon request.

FIVE HUNDRED AND FIFTY

LANTERN SLIDES AND STEREOGRAPHS

Selected and described with Special Reference to

STUDY OF PHYSICAL GEOGRAPHY AND GEOLOGY

BY

WALLACE W. ATWOOD, PH.D.,
Instructor in Physiography and
General Geology, University of Chicago.

JANE PERRY COOK,
Head of Department of Geography,
Chicago Normal School.

This series of slides has been selected and classified according to those topics in Physical Geography and Geology to be found in the best courses of study and in the modern text-books on these subjects. The classification has been systematic and thorough.

The catalogue of these slides, which may be obtained free upon request, is divided for ready reference into main topics, — Weathering, Sand Dunes, Rivers and River Valleys, Underground Water, Glaciers, Lakes, Shore Lines and Harbors, Vulcanism, Earthquakes, Mountains, Plains, Clouds, Storms and Life Forms in Various Physiographic Environments. Each main topic is logically divided into subdivisions, e. g., 49 pictures have been selected for the study of Glaciers under the following subtopics: — The Study of a Glacier, European Glaciers, Study of Glaciated Valleys and Ascent of Mt. Hood. Each slide has been most carefully selected as best adapted to each particular subtopic.

The value of this series is further enhanced by brief descriptive matter printed on the back of each stereograph and in the case of slides on slips of heavy book paper. These printed slips are put up in a neat and attractive booklet which is sent along with the order. When all the slides of a single topic are ordered the booklet makes a most valuable body of supplementary reading matter on the subject.

Single Slides	Each	**$0.40**
Per One Hundred		**35.00**

Send for Special Catalogue descriptive of these slides.

No. 49–100

49–100 KULLMER STAR CHART. This new astronomical instrument is based on the principle of the equatorial telescope mounting, — an arrow taking the place of the telescope. It is so simple and ingenious that it is fascinating to operate. In the cut the instrument is set for February 22, at 9 P.M. Place the arrow wherever you wish, and it will be pointing, when properly set, at the star-group shown and named in the opening of the indicator below.

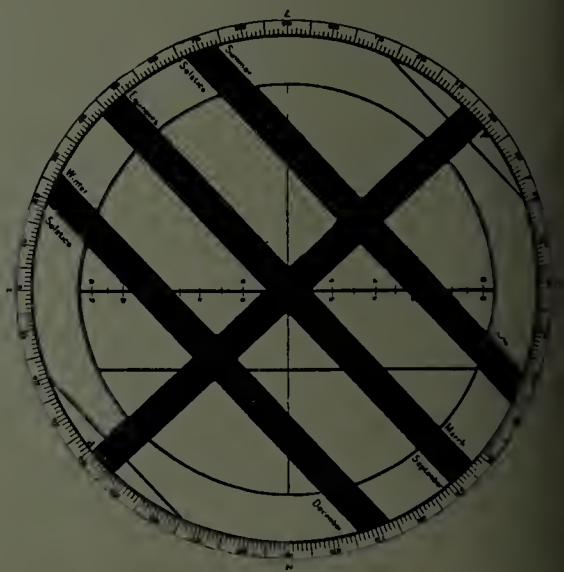
SOME OF THE THINGS IT TEACHES.

The apparent daily rotation of the whole sky.
Where stars, sun, moon and planets rise and set and the actual path taken by them.
The seasons, movement of sun north and south and path at solstices and equinoxes.
The constellations,—locations and names.
Sidereal and solar time.
Right Ascension and Declination.
Etc., etc., etc.

Made of nickeled metal with celluloid dial that can be washed when desired. With booklet "Star Maps and Star Facts" in neat leatherette case $5.00

49–110 SEASONAL TWILIGHT CHART, designed and copyrighted 1907 by Miss E. Rebecca Ellis of the Department of Physical Astronomy at Wellesley College, for showing:

The comparative lengths of day, night and twilight at any place at different seasons of the year.
The comparative lengths of day, night and twilight at different places at the same season of the year.
The absolute lengths of day, night and twilight at any place at any season.
The time of sunrise and sunset at any place at any season.
The azimuth of sunrise and sunset points at any place at any season.
The noon elevation of the sun at any place at any season.
The midnight depression of the sun at any place at any season.
The phenomena of the midnight sun.
The diurnal path of the sun at the poles (six months day and six months night).
The diurnal path of the sun at the equator (days and nights equal: and extremely short twilight).



No. 49–110

This chart is the orthographic projection of a globe upon a plane from a due east point in the plane of the horizon. The chart is 12 × 12 inches, divisions and figures distinct and legible and the size ample for use to advantage on the lecture table. The student, however, will gain a much clearer grasp of the whole subject if he works out the various problems with the chart in hand.

With full directions . . . . . .Each Chart **$1.00.** Per Dozen $9.00

No. 49-120

THE B-K SOLAR CALCULATOR

Invented by FRANK L. BRYANT

ERASMUS HALL HIGH SCHOOL, BROOKLYN, N. Y.

No. 49–120

The object of this ingenious instrument is to provide a simple apparatus for teaching the fundamental ideas of e apparent motion of the sun in relation to any point on the earth's surface and at any time of the year. It is ecially designed for the use of students in the laboratory for working out certain problems which will be noted low. It is also of value to the teacher in lecture work for all grades of geography instruction from the grammar ool to advanced work in the college.

This instrument, about 16 inches high and 16 inches wide, is especially adapted for the lecture table, although it s primarily designed for individual student use. A special feature in connection with the use of the instrument, d one entirely new, is that the horizon disc may be lowered and adjusted for plotting shadow curves at the time the solstices and equinoxes for different latitudes. This work was practically impossible before the introction of the B-K Solar Calculator. Its value, therefore, will be especially appreciated by teachers of Physical ography.

The following exercises may be performed by the use of the instrument:

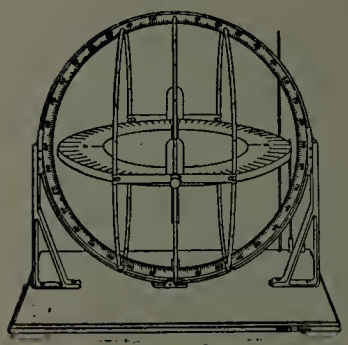
1. Find the time of sunrise and sunset at any latitude at any time of the year.
2. Determine the length of day at any latitude at any time of the year.
3. Find the relative distribution of insolation over the earth at different times of year.
4. Find the direction of sunrise and sunset at any latitude at any time of the year.
5. Find the altitude of the sun at any latitude at any time of the day or year.
6. Plot the curves of a shadow cast by an upright post at any latitude at the time of the solstices and equinoxes.
7. Interpretations of shadow curves.
8. Show relation of elevation of celestial pole to latitude.
9. Show relation of zenith distance of sun to latitude at different times of the year.
10. Show relation of length of twilight to latitude at different times of the year.

B-K SOLAR CALCULATOR, brass with oak base **$15.00**

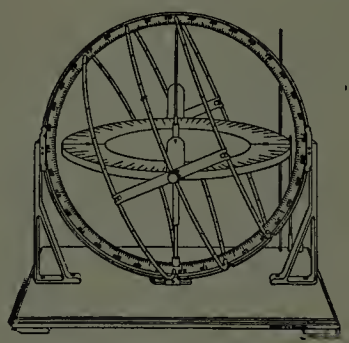
irections for use furnished with each instrument. Special price in lots of ten.

No. 49-120

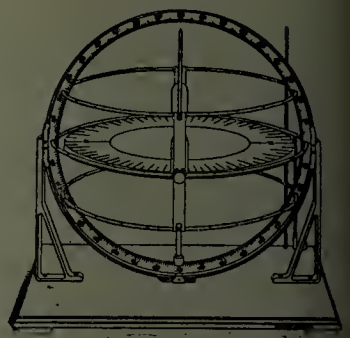
THE B-K SOLAR CALCULATOR



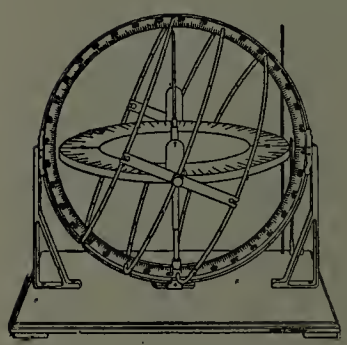
Set for the Equator



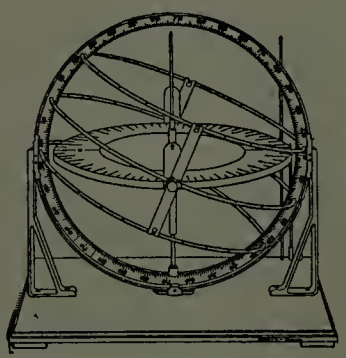
Set for Tropic of Cancer,
23½° N. Lat.



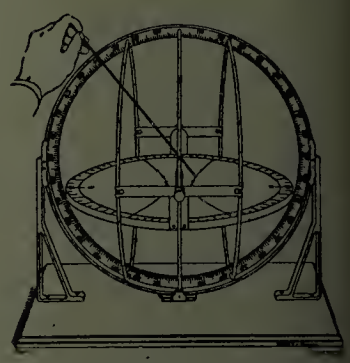
Set for the North Pole, 90°



Set for Tropic of Capricorn
23½° S. Lat.

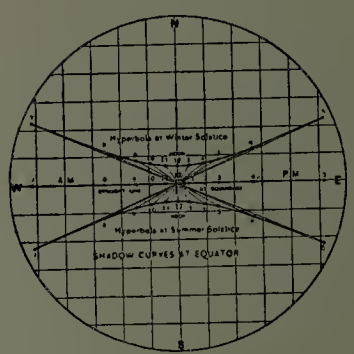


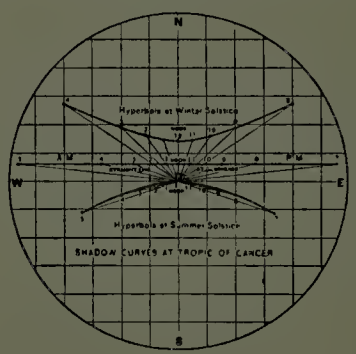
Set for the Arctic Circle
66½° N. Lat.

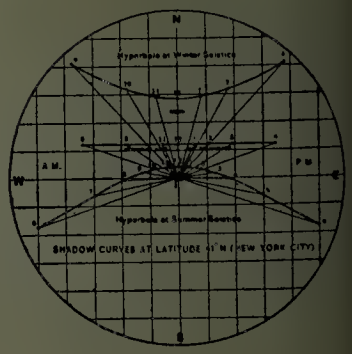


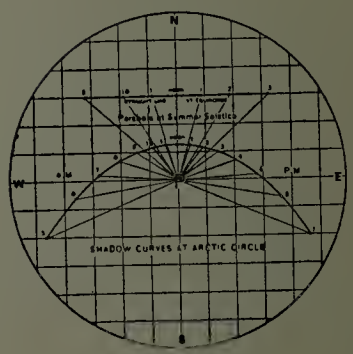
Set for plotting the Shadow
Curves at the Equator

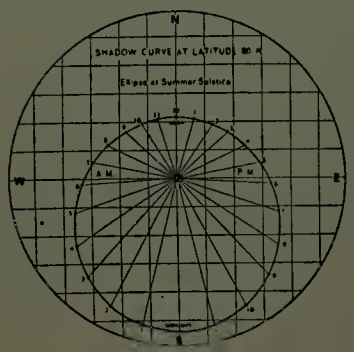
FORMS OF SHADOW CURVES

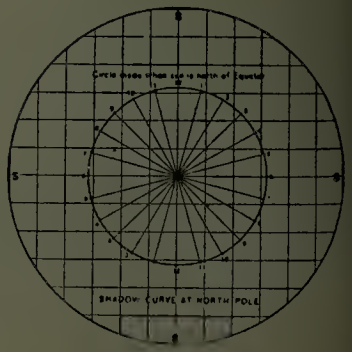












No. 49–175

CURTIS NATURALISTIC MODELS

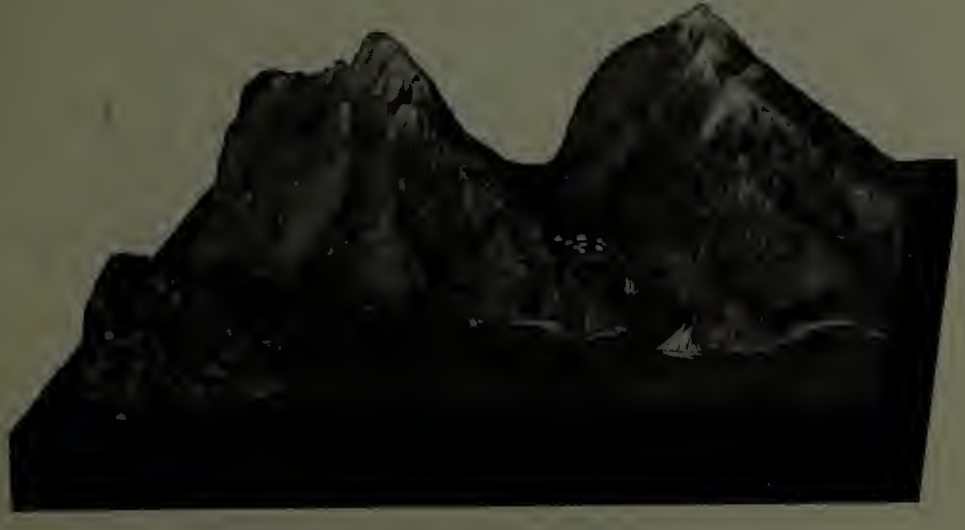
These models are true scale reliefs, 9 × 9 inches, representing the forms of the earth's surface, durably constructed of a special composition, beautifully colored to reproduce the color scheme of the natural object. They may be handled as readily as a school book and used wherever Geography is taught. They are especially adapted for work in connection with courses in Physical Geography. This wide range of service is due to the fact that each model is based on well selected types taken from actual occurrences in the field, and reproduced in very characteristic forms.

While it is true that the beginners will get but a small portion of what the advanced student may obtain, they will lose nothing by the completeness of the subject and what they do gain will come in the easiest way.

The set comprises six models, each enclosed in a book-cover case into which the models slide, permitting them to be handled and stored like books. The set consists of the following:

SEACOAST

No. I. SEASHORE BORDERING A PLAIN

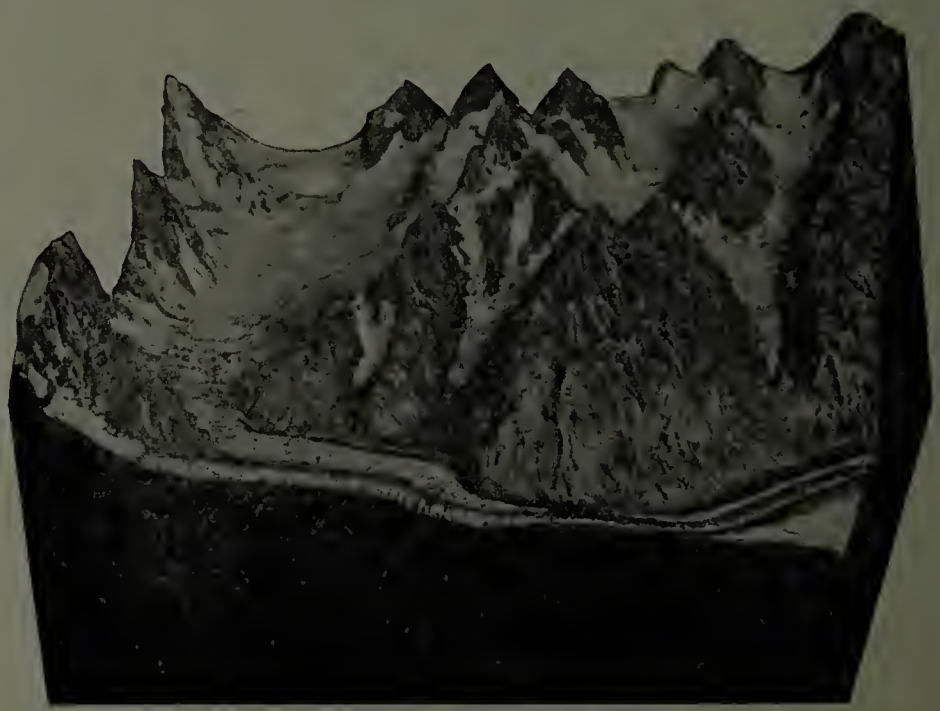


No. II. AN EMBAYED MOUNTAIN COAST

No. 49-175

CURTIS GEOGRAPHY MODELS

GLACIERS



No. I. HEAD OF A GLACIER

No. II. LOWER END OF A GLACIER

No. 49-175

CURTIS GEOGRAPHY MODELS

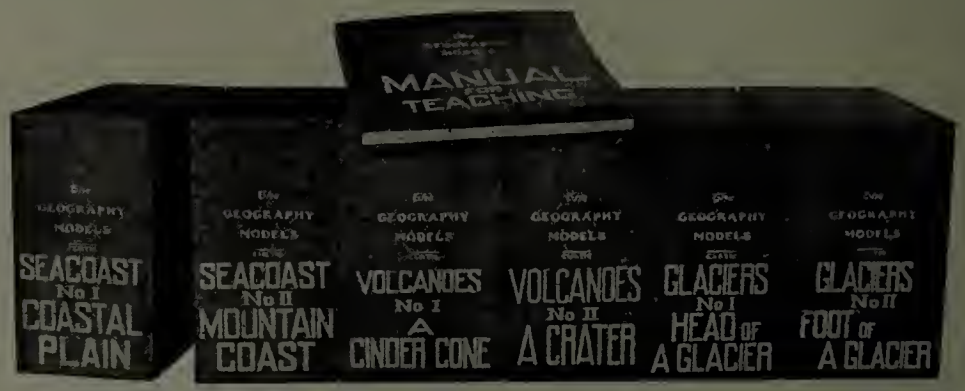
VOLCANOES

No. I. A FRAGMENTAL CONE
(VESUVIAN TYPE)

No. II. AN OPEN CRATER (CALDERA)

No. 49-175

CURTIS GEOGRAPHY MODELS


MANUAL
TEACHING
SEACOAST No I COASTAL PLAIN
SEACOAST No II MOUNTAIN COAST
VOLCANOES No I A CINDER CONE
VOLCANOES No II A CRATER
GLACIERS No I HEAD OF A GLACIER
GLACIERS No II FOOT OF A GLACIER

SET OF GEOGRAPHY MODELS IN COVERS

SEACOASTS

No. I. SEACOAST BORDERING A PLAIN.

A Plain which borders the sea.
Rivers which cut the plain and empty into the sea through an estuary.
A Harbor lying at the head of the bay at the mouth of the largest stream and on its shores.
A Seaport Town situated on the bay. Vessels may lie at the wharves, load and discharge cargoes well sheltered from storms.

No. II. EMBAYED MOUNTAIN COAST.

A Bay reaching up into the mountainous land.
Mountain Peaks which rise abruptly from the sea.
A Narrow Valley flanked by steep mountain sides.
A River flowing through the valley.
A Delta at mouth of the river and head of the bay.

VOLCANOES

No. I. FRAGMENTAL CONE (VESUVIAN TYPE.)

A Young Volcanic Mountain rising from the sea.
An Active Volcano at top of mountain; hot stones, ashes, lavas running down the sides of the mountain.
Lava **"Flows"** showing as hardened rock.
An Old Volcanic Mountain.

No. II. AN OPEN CRATER (CALDERA).

The Top of a Volcano, showing devastated region about the summit.
A Deep Crater Pit, a "Caldera."
An Old Crater partially filled with lava.
Fresh Lava.

GLACIERS

No. I. HEAD OF A GLACIER.

Mountain Peaks, sharp topped ridges.
Lofty Valleys, partially filled with snow and ice, descending steeply.
Snow Fields, masses of loose and compact snow which feed the Rivers of Ice.
Glaciers.

No. II. LOWER END OF A GLACIER.

The Foot of a Glacier.
The Head of a River, the melting glacier giving rise to a river.
An Open Valley.
An Alpine Village, low huts clustering near the foot of the glacier.

Complete set of six models, each in Book Cover Case, appropriately labeled, including a descriptive manual, a complete text on the subjects covered **$50.00**

SOUND

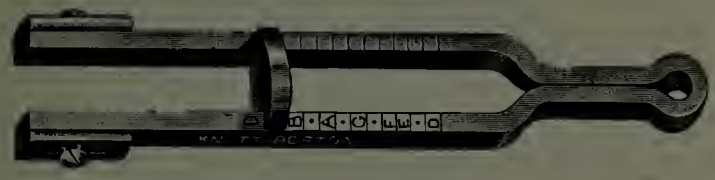
PROPAGATION OF SOUND

TUNING FORKS

In the selection of our **TUNING FORKS** we have been guided by the demands of the past which we have classified. We have, therefore, eliminated certain types and added forms of greater pedagogic value. Our policy is to furnish the best at the most reasonable prices, offering a line which will give the prospective buyer a range for choice.

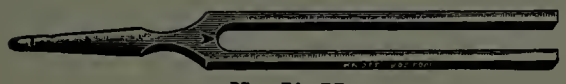
For ordinary work, we recommend our Nos. **51–50** to **51–87**. These forks are accurately tested and have, within a very small percentage of error, the stated vibration frequencies. For the highest scientific work, we recommend Nos. **51–90** to **51–125.**

All forks are tuned to the Physical Pitch, and, when a fork is mounted on Resonant Case, it must be understood that the case is accurately tuned in resonance with the fork.



No. 51–50

51–50 **UNIVERSAL PATENT ADJUSTABLE TUNING FORK,** U. S. Standard Pitch, nickel-plated . . **$1.10**



No. 51–55

51–55 **TUNING FORK,** 12 centimeters long, best polished steel, Pitch A **$0.13**
51–57 ——, 12 centimeters long, best polished steel, Pitch C . . . . . **.13**

Nos. 51–75 to 51–87

51–65 **TUNING FORK,** Pitch C = 128 VPS. about 25 centimeters long **$3.10**
51–75 ——, Pitch C^1 = 256 VPS. about 22 centimeters long **1.20**
51–76 ——, Pitch D = 288 VPS. about 21 centimeters long **1.45**
51–77 ——, Pitch E = 320 VPS. about 20 centimeters long **1.45**
51–78 ——, Pitch F = 341 1/3 VPS. about 20 centimeters long **1.45**
51–79 ——, Pitch G = 384 VPS. about 19 centimeters long **1.45**
51–80 ——, Pitch A = 426 2/3 VPS. about 19 centimeters long **1.25**
51–81 ——, Pitch B = 480 VPS. about 18 centimeters long **1.25**
51–82 ——, Pitch C^2 = 512 VPS. about 18 centimeters long **1.10**

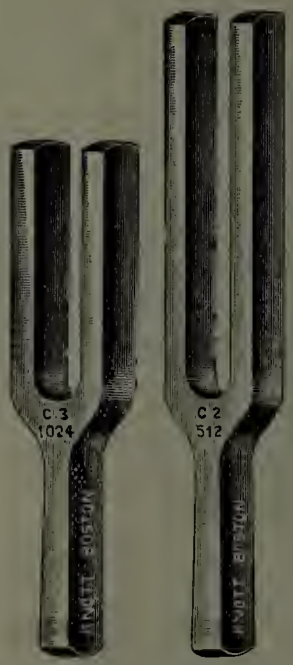
51–85 **TUNING FORKS,** set of four, giving the Major Chord, C^1, E, G, and C^2 . . . . . **5.10**

51–86 **MOUNTED TUNING FORKS,** set of four, C^1, E, G, C^2, as listed above, mounted on resonant cases **12.95**

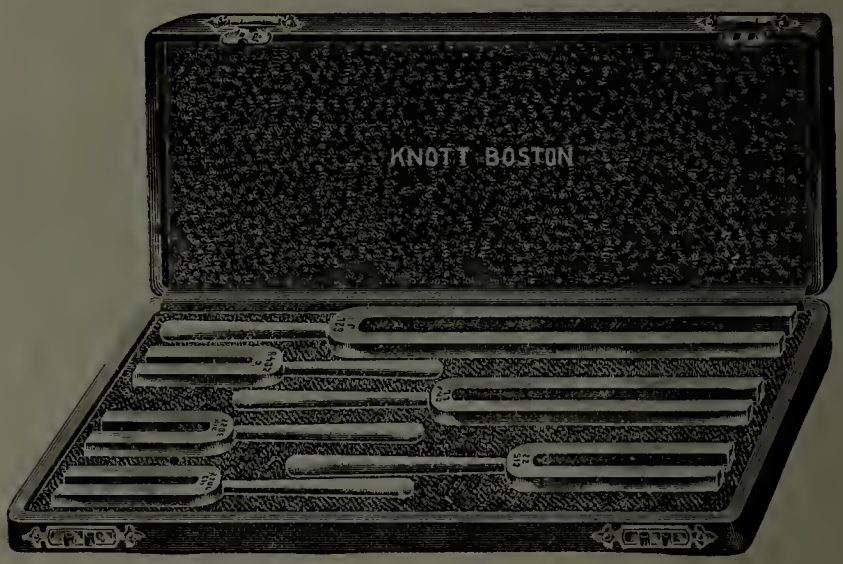
51–87 **TUNING FORKS,** set of eight, C^1 to C^2, giving full Octave. Same forks as Nos. **51–75** to **51–82** **9.85**

51–88 **RUBBER HAMMER,** small . . . . . **.14**

51–89 **LARGE LECTURE TABLE PURE GUM RUBBER HAMMER,** finely finished handle . . . . . **.65**



Nos. 51–90 to 51–106



No. 51–115

51–90 **NORMAL TUNING FORKS** of excellent quality, finely nickel-plated, accurately adjusted. Set of eight forks, from C = 64 VPS. to C = 128 VPS., the largest fork about 40 centimeters long, the smallest about 36½ centimeters . . . . . Duty Free . . .

51–95 ——, same quality as above, set of fifteen forks, from C = 64 VPS. to C^1 = 256 VPS. The largest fork about 44 centimeters long, the smallest about 23 centimeters . . . . . Duty Free . . .

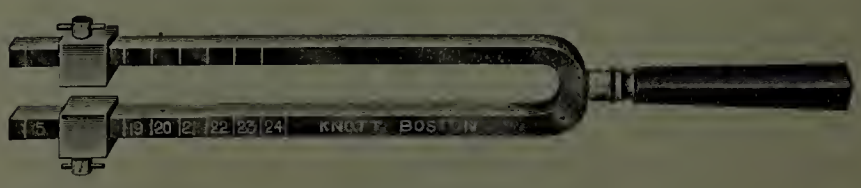
51–100 ——, same quality as above, set of eight forks, from C = 128 VPS. to C^1 = 256 VPS. The largest fork about 36½ centimeters long, the smallest about 23 centimeters . . . . . Duty Free . . .

51–105 **EXTRA HEAVY TUNING FORK,** C = 64 VPS., 44 centimeters long . . . . . Duty Free . . .

51–106 ——, C = 128 VPS., 35 centimeters long . . . . . Duty Free . . .

51–115 **STANDARD NORMAL TUNING FORKS,** highest quality and precision, especially designed for research in acoustical phenomena. Set of six large nickel-plated Forks, C = 128 VPS., C^1 = 256 VPS., C^2 = 512 VPS., C^3 = 1024 VPS., C^4 = 2048 VPS., and G^4 = 3072 VPS. Each with a vibration period of 30 seconds. Enclosed in handsome plush-lined case . . . . . Duty Free . . .

51–120 **STANDARD NORMAL TUNING FORK,** finest quality, highest precision, worked out of a heavy piece of steel, not cast, with certificate of accuracy from the Physikalische Techniche Reichsanstalt. Enclosed in neat case . . . . . Duty Free . . .

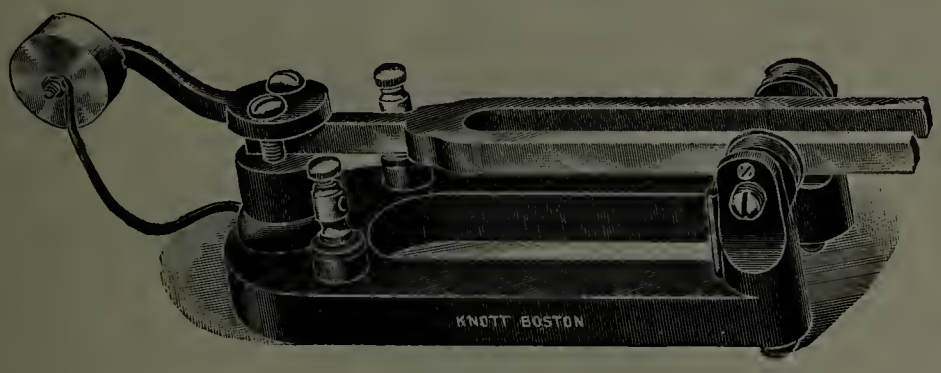


No. 51–125

51–125 **FIFTY-CENTIMETER TUNING FORK AFTER BEZOLD,** for demonstrating the minimum limit of the normal ear for sound.

This is a polished steel fork, 500 millimeters long, with a prong 350 millimeters long, each prong 21 × 9 millimeters. Each fork has received the most painstaking care in construction and is carefully adjusted. Adjustable ballast weights are provided giving vibration frequencies from 15 to 24. Handsomely polished . . . . . Duty Free . . .

ELECTRO-SYNCHRONISM-DRIVEN RECORDING FORK



Nos. 51–135 to 51–140
Patent Pending

In our electro-synchronism-driven tuning fork we believe that improvements of the greatest importance have been made in the fundamental instrument, improvements which will give the closest approach to an ideal fork. In our method, an especially designed Microphone is mounted on the base of the instrument. This Microphone picks up the vibrations thrown from the fork, and in turn varies the strength of the electro-magnets which actuate the fork, leaving the prongs free to vibrate unhampered by contacts or springs such as were formerly used. In use the binding posts are connected to the source of current, 4 cells of dry battery being recommended.

The synchronism that takes place is shown in a very striking manner. Starting with an almost imperceptible vibration, the fork gradually reaches its highest amplitude, when it will continue to give forth a tone of great purity, with absolute freedom from all other foreign sounds or vibrations which have proved so troublesome in forks constructed by ordinary methods. The synchronism method insures the fork giving its actual tone, a result not obtained by any other method.

Electrically Driven Tuning Forks in which the electric contact is made directly on the prongs either by a spring attached to one prong or by a platinum contact soldered to it, have the following objections: —

1. **The prong of the fork carrying the contact or spring is dampened,** and the fundamental tone of the fork is radically changed thereby.
2. **The vibration of the fork is forced to an unnatural pitch** by means of the sudden rush of current due to its intermittent contact.
3. **The contact point emits a sound** often sufficient to obscure the fundamental tone of the fork.
4. **An adjustment that will give the natural clear tone of the fork is impossible,** owing to the unavoidable noise due to this method of vibration.

In the **Electro-Synchronism-Driven Tuning Fork** we justly claim the following features: —

1. The fork has nothing to carry.
2. The vibration is absolutely dependent upon the natural period of the fork.
3. There are no parts of the apparatus to take up vibrations and give any undesirable sounds.
4. The fork is actuated by a current that varies in strength from maximum to minimum in absolute synchronism with its own period.
5. The vibrating apparatus is absolutely distinct and unattached to the fork and hence produces no distortion in vibration.

As the principal object of this apparatus is to maintain for a considerable period a uniform tone and vibration coming from a fork having a definite vibration period, we list the apparatus designed for adjusted forks of 128 and 256 vibrations. We desire to call particular attention to the fact that these forks are of the best quality, furnished us by a prominent European manufacturer.

51–135 **ELECTRO-SYNCHRONISM-DRIVEN RECORDING FORK,** including base and imported fork No. **51–106,** 35 centimeters long, 128 VPS. **$17.25**

51–137 ——, same as above, but with No. **51–75** fork, 22 centimeters long, 256 VPS. **9.50**

51–140 **UNADJUSTED TUNING FORK, large size,** for use with No. **51–135.** It is frequently desirable to use an electrically driven tuning fork designed so that the stylus for recording the vibrations on a moving surface may be attached; also one in which the mirrors for use in tracing Lissajous' figures may be used. Where these attachments are added the absolute vibration of the fork cannot, of course, be depended upon, since the prong must carry a load. For this work, therefore, a fork which has not been especially adjusted is entirely adequate. The fork which we furnish under this number is one of unusually substantial construction, approximately 15 inches long, giving about 100 vibrations per second and supplied with threaded holes on the ends of the fork for carrying binding screws which hold the recording stylus, also for carrying the mirrors listed below, used in Lissajous' experiments . . . .
Complete with stylus **6.75**

51–141 ——, small size for use on No. **51–137** **1.35**

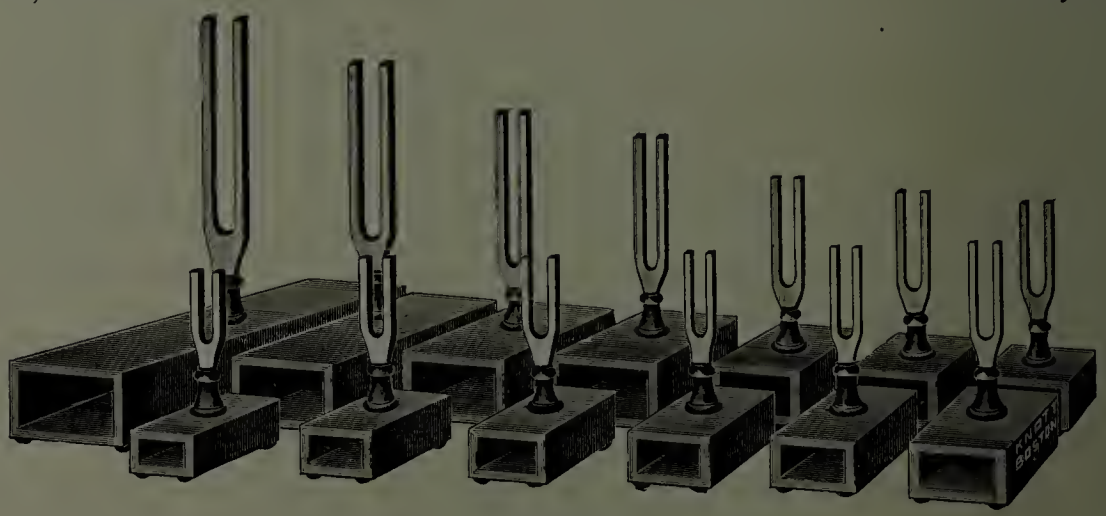
51–142 **MOUNTED MIRRORS FOR LISSAJOUS' CURVES** supplied with threaded stems fitting the holes of the fork No. **51–140** . . . . . Per Pair **2.50**

Nos. 51–150 to 51–161

51–150 **LARGE MOUNTED TUNING FORKS,** most careful workmanship, highest accuracy, mounted on synchronized resonant cases. Set includes four large forks from C^1 = 256 VPS. to C^2 = 512 VPS., each mounted on a separate case. With rubber hammer . . . . . Duty Free . . .

ABOVE FORKS SEPARATELY LISTED

51–155 **LARGE MOUNTED TUNING FORK,** C^1 = 256 VPS. . . . . Duty Free . . .
51–157 ——, E = 320 VPS. . . . . Duty Free . . .
51–159 ——, G = 384 VPS. . . . . Duty Free . . .
51–161 ——, C^2 = 512 VPS. . . . . Duty Free . . .



No. 51–180

51–175 **LARGE MOUNTED TUNING FORKS,** same quality as above. Set of eight forks, giving the Octave, C^1 = 256 VPS. to C^2 = 512 VPS., each mounted on resonant case . . . . . Duty Free . . .
51–180 ——, same as above, set of thirteen, from C^1 = 256 VPS. to C^2 = 512 VPS.; each mounted on synchronized resonant case . . . . . Duty Free . . .

51–190 **SYMPATHETIC TUNING FORKS** for showing sympathetic vibrations, also "beats."

Consists of a pair of large tuning forks, accurately adjusted to 256 VPS. per second, mounted on separate synchronized resonant cases. One of the forks is supplied with a slide to destroy the unison to show "beats." Complete with large rubber hammer, Duty Free . . . . . .

51–192 ——, extra large, same quality as above, but accurately adjusted forks of 128 VPS., Duty Free . . . . . .

No. 51–190

No. 51–205

No. 51–212

No. 51–250

51–205 **THE MORSE SYMPATHETIC VIBRATION APPARATUS,** for the study of sympathetic vibrations in simple pendulums and for determining under what conditions two bodies will vibrate in sympathy. The apparatus clearly shows what is meant by the expression, "natural period of swing."

The apparatus consists of a tripod stand on which is mounted the vibration apparatus consisting of four simple pendulums in bi-filar suspensions and a compound pendulum with adjustable disc bob, all suspended from a common swivel support.

If the compound pendulum is set vibrating the simple pendulum the vibration period of which is synchronous will begin to vibrate.

Apparatus complete with tripod stand **$8.40**

51–206 ——, same as above but without tripod stand and support **5.25**

51–210 **CHEMICAL HARMONICON or SINGING FLAME,** showing that the air in an open tube may be made to give a sound by means of a luminous jet of gas.

The apparatus consists of a tube about 2 centimeters in diameter of the carefully calculated length to respond to the jet or the burner, also supplied with the apparatus.

Tube complete with burner **2.50**

51–212 **CHEMICAL HARMONICA,** similar to No. **51–210,** but designed to sound the chord.

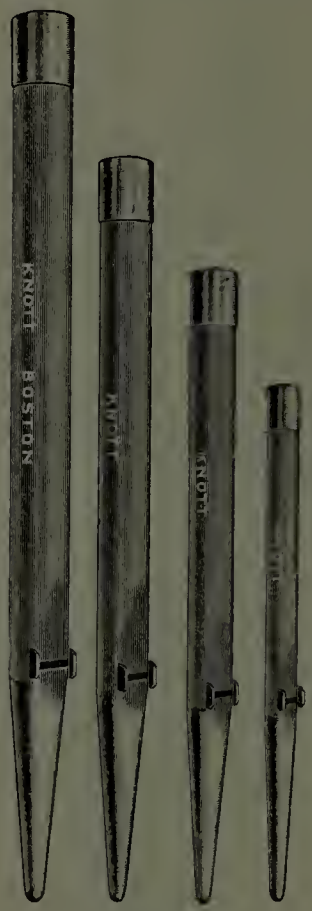
The apparatus consists of four tubes similar in design to No. **51–210,** but all mounted on a common stand with special burner.

Complete as illustrated **14.50**

51–250 **GLASS WHISTLE WITH SLIDING PISTON** for determining the "fundamentals" of closed pipes.

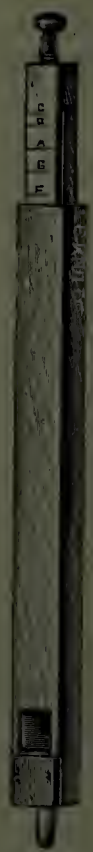
This consists of a glass tube in which is a sliding piston and to which is fastened a second tube in such a position that air blown through it will cause the air column in the first tube to emit a tone which may be proved the "fundamental" of the tube **1.25**

No. 51–240



No. 51–275

No. 51–290



No. 51–295

51–240 **GALTON'S WHISTLE** for determining the highest limit of audibility, — calculated vibrations up to 85,000 per second possible.

This is an accurately constructed instrument, all dimensions calculated to a scientific nicety. Each part is carefully fitted, neatly polished, and lacquered. Results possible fully warrant its expense. **$9.85**

51–243 **GALTON'S WHISTLE** for determining the upper limit of audibility.

This instrument is similar in appearance to No. **51–240,** but designed and constructed by Dr. M. Th. Edelmann. It has an improvement in form of a double adjustment and a large throat. It attains the highest degree of accuracy and is handsomely finished throughout. Complete directions and valuable data are furnished with each instrument.

Enclosed in leather case . . . . . Duty Free **16.50**

51–275 **ALL METAL ORGAN PIPES,** set of four giving the Chords, C^1, E, G, and C^2.

These pipes are carefully constructed from metal, and from actual experimentation are found to give the best results, far in excess of pipes constructed of wood. They are especially constructed for us and we have added to their pedagogic value by the attachment of a Sliding Tuning Tube which is designed to change the tone by lengthening the tube.

These pipes will be found a valuable addition to any laboratory and their handsome appearance will certainly add to the appearance of the scientific equipment **9.50**

51–285 ——, same as above, but a full set of eight pipes sounding the octave from C^1 to C^2 . . . . . **18.75**

51–290 **DEMONSTRATION ORGAN PIPE** for showing the vibrating segments and nodes of an organ pipe by means of a membrane.

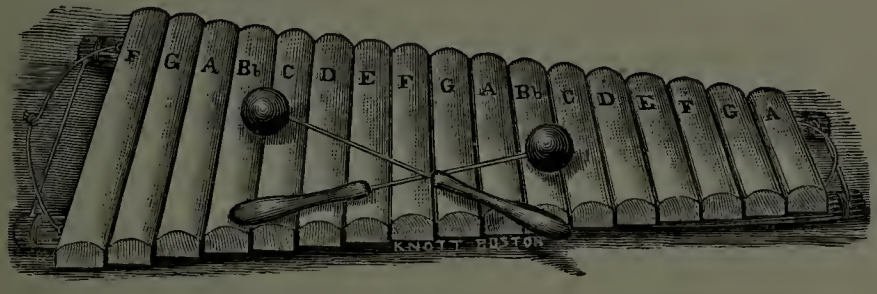
This consists of a wooden pipe, one side of which is of glass. Fitting within this pipe is an adjustable membrane, the height of which in the tube can be regulated by means of a rod to which the membrane is attached.

On lowering the membrane, in the tube, until it reaches a node, a pure tone is produced; but on raising or lowering the membrane a few centimeters, a harsh note is given out. On covering the membrane with a little sand or cork dust and changing its height in the tube, it will be seen that the sand or dust is disturbed at all positions except at the nodes **4.00**

51–295 **DEMONSTRATION ORGAN PIPE WITH MOVABLE STOP** for sounding two octaves with tones and semi-tones distinctly marked on the frame which operates the stop **4.00**

No. 51–310

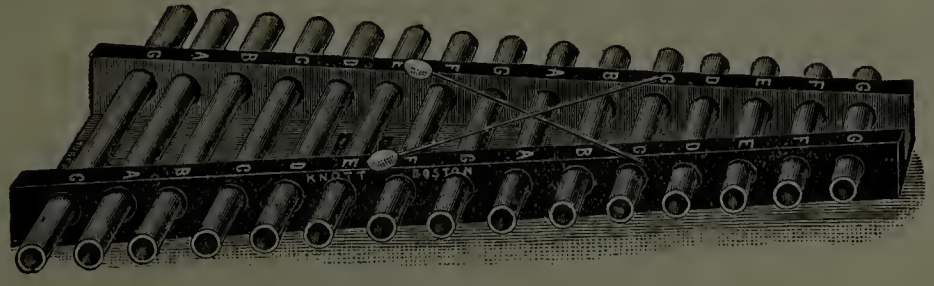
51-310 **MOUNTED TUBE** for showing transmission of sound by liquids.
This apparatus consists of a glass tube with funnel-shaped open end, mounted on resonant case.
If stem of vibrating fork is held at open end it may be shown that no sound is transmitted; if, however, the tube is filled with water and the stem touches the surface of the liquid, sound is transmitted. . . . . Duty Free **$8.50**



No. 51–315

51-315 **XYLOPHONE** showing musical tones from vibrating wooden bars. Consists of fifteen maple bars mounted on wood frame and accurately tuned to sound two octaves. With two hammers . . **$1.25**

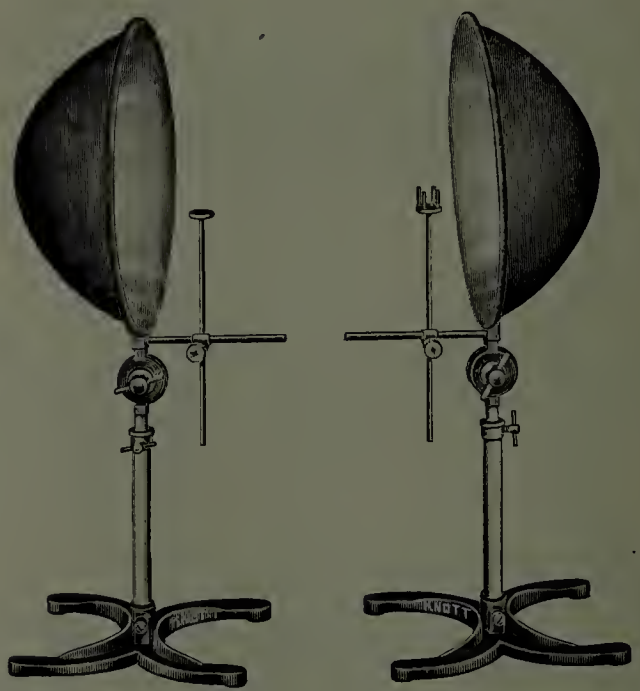
51-320 **METALAPHONE** for showing musical tones emitted by vibrating metal. Consists of twelve metal plates carefully tuned and mounted in ornamented wooden frame. With two hammers **1.25**



No. 51–325

51-325 **TUBEPHONE** showing musical tones emitted by vibrating tubes. Consists of fifteen brass tubes highly polished, mounted in wooden frame. With two hammers, in cardboard box **$1.95**

REFLECTION, REFRACTION AND INTERFERENCE OF SOUND WAVES



No. 52-10

52-10 THIRTEEN-INCH UNIVERSALLY ADJUSTABLE TRUE PARABOLIC REFLECTORS for demonstrating Reflection of Sound, Heat and Light Waves.

In offering for sale our Improved Reflectors we desire to emphasize the **TRUE PARABOLIC SURFACES.** The curves of these surfaces have been accurately calculated and drawn and then by painstaking processes a chuck has been turned to the true parabolic curve. Our Reflectors are all spun from this chuck. The reflecting surface is then highly polished and heavily nickel-plated, presenting an excellent surface without waves.

The Reflectors are mounted in a two-part circular casting in such a manner as to entirely obviate any danger of distorting the surfaces. This two-part casting is brought together at the bottom, where it makes a swivel junction with a rod which telescopes into the supporting base.

The holders and attachments are all of special design which allows of both coarse and fine adjustments. We, therefore, secure a tilting movement for the Reflectors, an adjustment for proper height, and universal movements for each attachment.

In illustrating Reflection of Sound a simple experiment is possible by attaching a watch to one of the carriers at the focus of one reflector; if now one end of a flexible tubing is placed at the focus of the other reflector attached to the carrier and the other end terminating in a large funnel, megaphone, or horn, the ticking of the watch may be heard by the majority of the class.

The finish of this instrument is fully in keeping with the design. The outer surfaces of the Reflectors are dull oxidized, the H Base bright japan, and all brass parts polished and nickel-plated.

Thirteen-Inch Universally Adjustable True Parabolic Reflectors complete as illustrated with attachments . . . . . Per Pair **$17.50**

52-15 ——, same as above, mounted on stand but without attachments or carriers . . . . . Per Pair **13.50**

No. 52–30

52–30 SOUND LENS, for experiments on the refraction of sound.

The apparatus consists of a double-walled rubber diaphragm re-inforced by a rolled metal ring and provided with an outlet for inflating with gas, refractive power of which is to be studied. This outlet is also convenient for regulating the curvature and hence the refractive power of the lens.

A source of sound is placed in the direction of the axis; the point is then sought on the other side of the lens at which the sound is most distinctly heard. This point will be the focus, and at all other points the sound is scarcely perceptible, showing that sound has been refracted by the lens in much the same way as light is refracted by a glass lens.

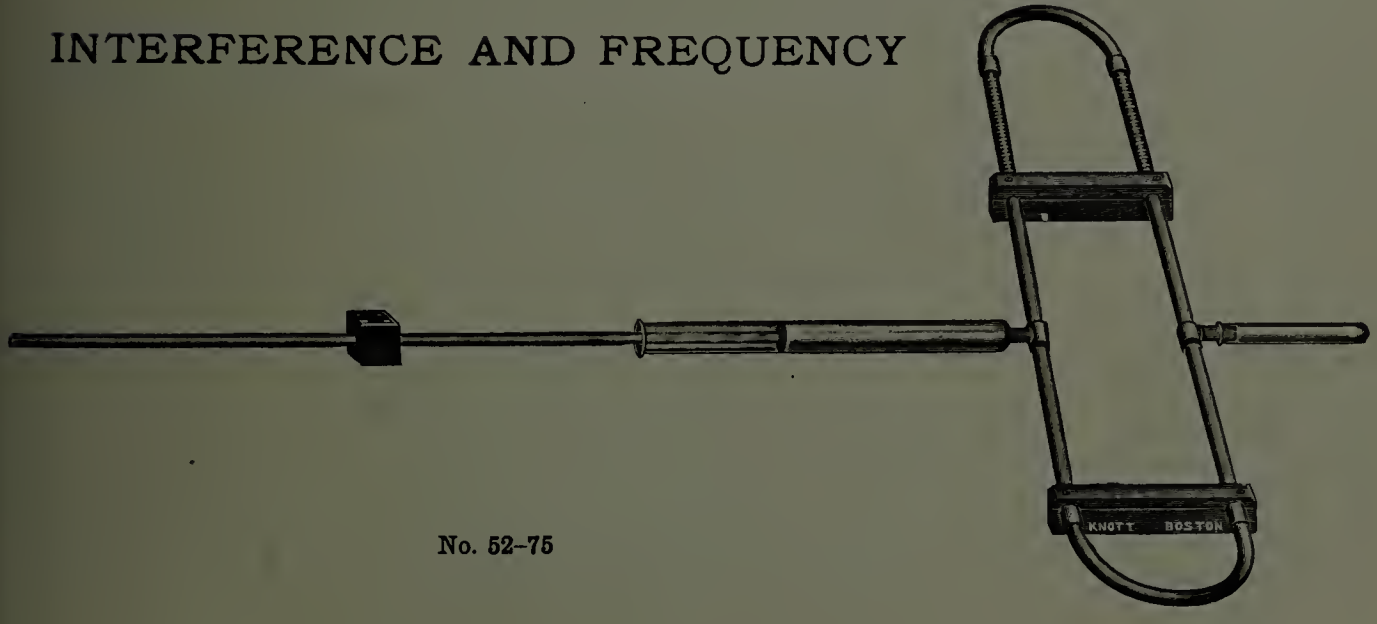
This apparatus is supported by a simple and effectively designed base and supporting arm so arranged as to give ample adjustment and full range in the angle of inclination.

Sound Lens complete, with stand, as illustrated **$9.80**

52–32 SOUND LENS only, ready for mounting on stand **6.75**

52–40 EAR TRUMPET, for concentrating sound waves. This is a neatly finished metal instrument designed to reflect and concentrate sound waves **2.50**

INTERFERENCE AND FREQUENCY



No. 52–75

52–75 KUNDT'S INTERFERENCE APPARATUS for the quantitative study of Interference of Sound Waves.

This apparatus consists of two U-shaped nickel-plated brass tubes, one provided with supporting cross bars; the other has both arms graduated, telescoping into the first. To one of the parallel sides of this interference tube is attached a closed glass tube which in use contains cork dust or lycopodium powder. To the other side is attached a glass tube with supported sliding piston. In use, vibrations are set up in the piston tube with the movable telescoping part of the interference tube pushed home, then with this part so that it represents 1, 2, 3, 4, 5, etc. quarter wave-lengths. It will be noted that figures are produced with the even numbers and are not formed with the odd numbers of quarter wave-lengths. Mounted on well finished wood base **$15.00**

No. 52–80

No. 52–85

No. 21–245

52–80 INTERFERENCE TUBES after QUINCKE for use with $C^1 = 512$ VPS., in illustrating interference of sound waves.
The apparatus consists of two T-shaped glass tubes of equal diameter connected as illustrated by rubber tubing.
If a tuning fork is sounded before the open end of the long tube, and the open end of the other tube is held to the ear, there will be no sound heard providing the length of the tube connecting the branches of the T-tube is one-half the wave-length of the note produced by the fork. If, however, this rubber tube be closed by pinching it, the note is at once heard.
Complete with rubber tubing as illustrated $0.90

52–85 HOPKINS' METAL FORK TUBE after Gage's "Introduction to Physical Science," Exp. 255, for study of interference with a Chladni's Plate (see Nos. **54–126** and **54–134**).
This consists of a forked metal tube with adjustable extension.
In use, the plate is bowed so that the two diagonals are distinctly formed. If the fork of the Interference Tube is held over two non-contiguous sectors, the sand strewn on the membrane is violently agitated. If the fork is held over two contiguous sectors, the sand is not disturbed 3.15

No. 53–40

21–225 SAVART'S WHEEL, COLOR AND SIREN DISC combined. (See Section 21.) 1.50

21–240 SAVART'S WHEEL for use on Rotator, consisting of four discs of metal in the periphery of which are cut teeth, the number forming a simple ratio to give a harmonic chord 2.35

21–242 SAVART'S WHEEL, a single disc for attachment to Rotator 48

21–245 SAVART'S WHEEL for demonstrating that pitch is proportional to the number of vibrations per second.
The apparatus consists of a heavy cast toothed wheel mounted on steel pinions in a forked stand. This wheel may be rotated by means of a cord. If a card is held lightly against the teeth of the wheel during rotation, a note will be sounded, the pitch depending on the speed of the wheel 7.65

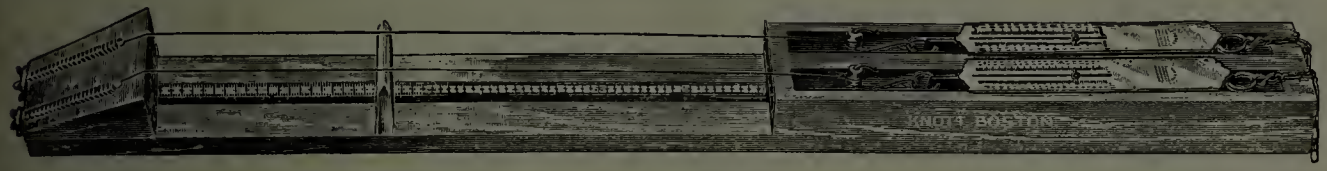
53–40 CAIGNARD-LATOUR SIREN WITH COUNTERS. This is a carefully constructed scientific instrument, a product of a firm well known in Europe for accurate designs of acoustical apparatus. It is handsomely finished throughout . . . . . Duty Free . . .

53–42 CAIGNARD-LATOUR SIREN WITHOUT COUNTERS. This instrument is similar in design to the one above but without counters. Duty Free . . .

53–45 DEMONSTRATION CAIGNARD-LATOUR SIREN WITHOUT COUNTERS. This is a greatly simplified form of the above. 9.00

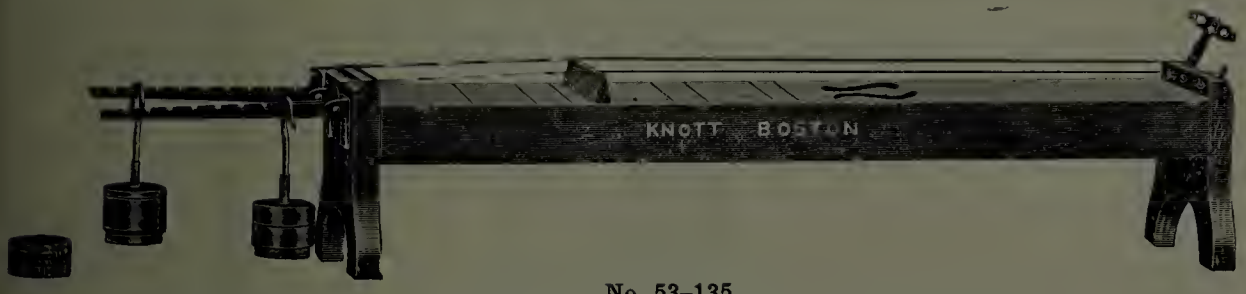
SONOMETERS

Our Sonometers are made from selected well seasoned wood very carefully glued up and finely finished. We list below only those designs which have in actual use given the most efficient service. Each sonometer is supplied with wires and necessary bridges. On each case beneath the wires, there is a metric scale on which is also indicated the lengths of strings necessary to give both the Diatonic and the Equally tempered scale between C = 256 VPS. and C = 1024 VPS.



No. 53–100

No. 53–115



No. 53–135

No. 53–125

53–100 **SONOMETER.** This sonometer is complete as illustrated, requiring no accessory weights, scale pans, etc. Tension is caused by dynamometers, fine adjustment of tension being secured by turning the wing nut sat the end of the slow motion screws to which the wires are attached. Length 1½ meters over all. Complete as illustrated $8.15

53–101 ——, without dynamometers 4.85

53–102 **SONOMETER WIRES,** set of three wires as used in above . . . . . Set .20

53–115 **NATIONAL THREE WIRE SCHOOL SONOMETER** after Turner and Hersey, Exp. No. S 040. Requires no accessory weights, scale pans, etc. Three wires attached, each with tension spring of 25 pounds capacity. Fine adjustment of tension secured by piano tension keys 4.50

53–117 **SONOMETER WIRES,** set of three as used in No. **53–115.** . . . . . Set .20

53–125 **VERTICAL WALL FORM SONOMETER.** Recommended in that it takes little space and that the tension is applied direct. With two wires, bridge clamps, etc., as illustrated, but without hangers and weights 11.50

53–127 **SONOMETER STRINGS,** 0.014 and 0.028 inch diameter as used on above Sonometer . . . . . Pair .35

53–135 **LEVER TENSION SONOMETER.** Tension adjusted by weights sliding on levers, fine adjustment by tension keys. Without weights 7.80

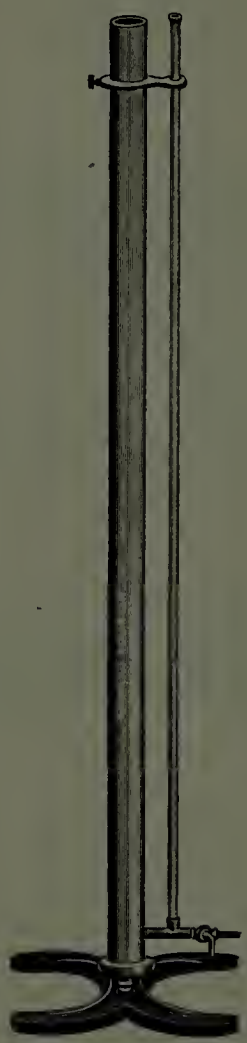
53–137 **DIRECT TENSION SONOMETER.** Tension secured by means of weights to be attached to cords over freely running pulleys. Without weights 7.80

53–138 **DIRECT TENSION SONOMETER,** similar to above, but with tension keys and complete with necessary hangers and weights 10.60

53–139 **KEY TENSION SONOMETER.** Tension secured by Keys only 7.25

RESONANCE TUBES

No. 53–200



No. 53–205

No. 53–215

53–200 **KNOTT'S ONE HUNDRED AND FIFTY CENTIMETER RESONANCE APPARATUS,** for determining the wave length of a tuning fork; also for determining the velocity of sound in air.

The apparatus consists of a metal upright with metric scale mounted on our H-base. To the rods of this upright are attached the clamps for holding the required accessories. Thus the resonant tube is supported at the left by Nos. **5–887** and **5–889** Clamps, and the reservoir at the right by No. **5–885** Clamp, the fork at the top by one each of our Nos. **5–450** and **5–891** Clamps. The apparatus is designed to support a tube of sufficient dimensions so that with a $C^1 = 256$ VPS. Fork a resonating column of ¾ of a wave length is possible.

Apparatus neatly finished throughout, complete as illustrated but without fork **$8.50**

51–75 **TUNING FORK,** $C^1 = 256$ VPS. **1.20**

53–205 **FIVE-FOOT METAL RESONANCE TUBE WITH WATER LEVEL INDICATOR,** for determining the Velocity of Sound in Air; also for determining the Wave Length of a Tuning Fork.

This is a metal tube, five feet in height, mounted on our H-base. At the lower end of this tube is a lateral tube with stop-cock, which can serve either as an inlet or as an outlet tube as may be desired. A glass tube of the same length as the metal tube connected to this lateral tube serves as an indicator for registering the length of the resonating air column.

This design combines advantages of other types, and has the further feature of facility of measurements of air columns, ease in varying height of water level, and extreme durability **6.25**

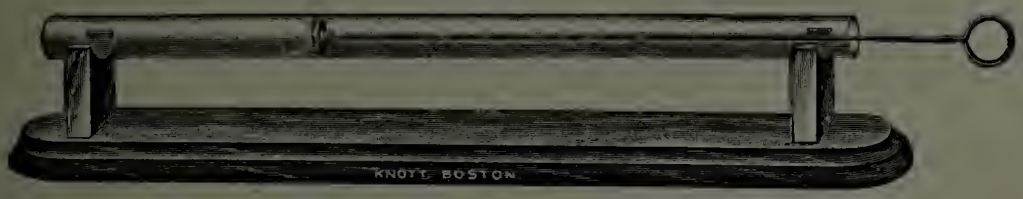
53–215 **ONE HUNDRED AND FIFTY CENTIMETER RESONANCE APPARATUS,** after Ames & Bliss' "Manual of Experiments in Physics," Experiment 40.

This apparatus consists of a long glass tube with a small side tube attached near the open end, the bottom of which is tapered so as to join with a length of rubber tubing connected either with the water tap or as illustrated with a reservoir for water.

This apparatus is mounted as illustrated on a supporting stand, as described above.

Complete as illustrated, but without tuning fork **9.25**

53–225 **CULLER'S RESONANCE APPARATUS,** without support . . . . . **.81**



No. 53–230

53–230 HORIZONTAL RESONANCE TUBE, for measuring the velocity of sound in air.
This is a glass tube mounted horizontally on a convenient wooden support. It is provided with a sliding piston for regulating the length of the active air column. This will be found a convenient students' apparatus $2.25

53–235 GLASS RESONANCE TUBES, with smooth ends, for use in resonance experiments.

	a	b	c
Length, centimeters	55	110	110
Diameter, centimeters	3.5	3.5	4
Each	$0.85	1.20	1.90

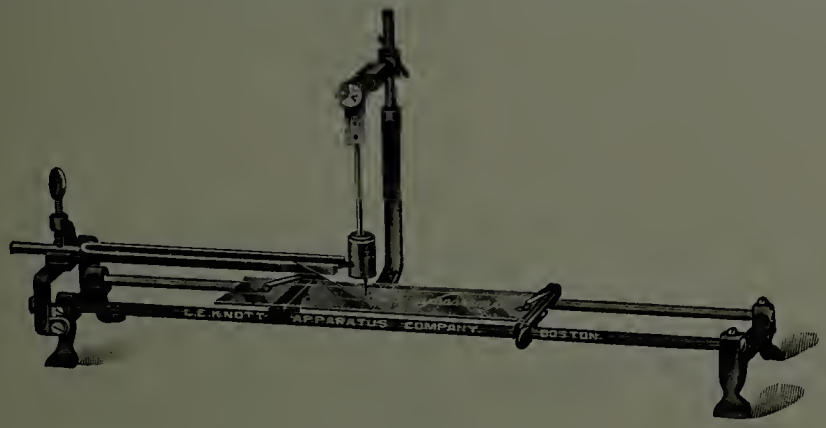
31–250 RESONANCE GLASS JARS, for use in resonance experiments. These jars are of clear white glass, with foot and rim.

	a	b	c	d	e
Size, inches	12 × 1½	12 × 2	15 × 2	15 × 3	18 × 3
Each	$0.50	.55	.80	1.00	1.35

STUDY OF SOUND VIBRATIONS

RECORDING APPARATUS—LISSAJOUS' CURVES—CHLADNI'S PLATES MANOMETRIC FLAME APPARATUS—SONOGRAPH

GRAPHIC REPRESENTATION OF SOUND



No. 54–15
Patented Aug. 13, 1907

54–15 KNOTT'S UNIVERSALLY ADJUSTABLE VIBROGRAPH, for determining the vibration frequency of a tuning fork.
The results of experience have demonstrated that a Vibrograph built of wood has many objectionable features. We have, therefore, discarded wood altogether in this, our new design. Two nickel-plated rods held firmly in end supports form the track along which the carriage bearing the smoked-glass plate moves freely. An upright fastened to one track bears the rod to which is fastened the clamp supporting the pendulum. The tuning fork, to one prong of which must be fastened a bristle, is clamped as pictured at left of illustration in a frame which is adjusted by means of a thumb nut and which in turn adjusts the plane of the fork.
In addition to the substantiality of this design, our claims for accuracy with a minimum of trouble are fully warranted. The handsome appearance of the instrument will enhance its value as an acquisition in any well-equipped laboratory.
Complete as illustrated, but without fork $4.00

54–15a COATED PAPER. A special coated paper has been provided for use on above Vibrograph. This paper has the property of turning dark whenever rubbed by brass, aluminum or similar metals. It will be found valuable in making permanent records. . . . . Per Package of 25 Sheets .15

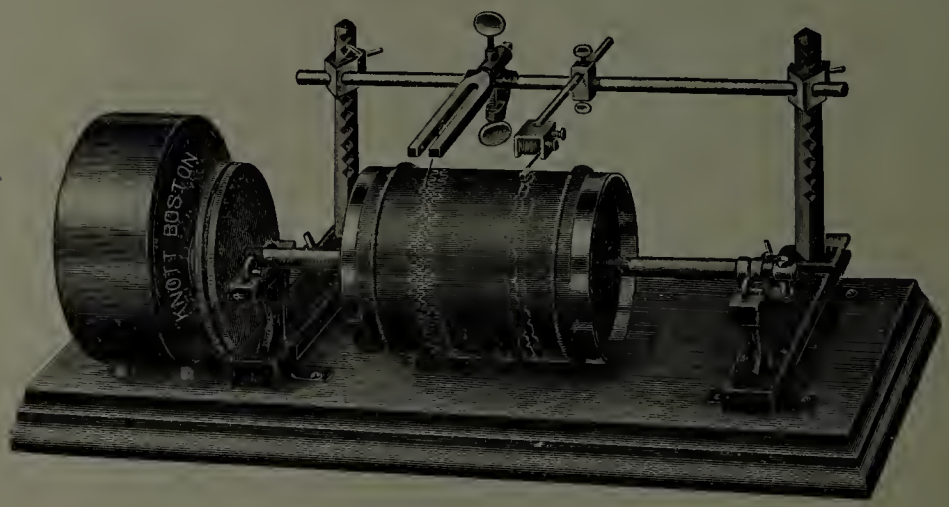
54–16 VIBROGRAPH TUNING FORK with stylus, low pitch, large amplitude 1.35

54–17 EXTRA GLASS PLATES, for use with above **VIBROGRAPH** . . . . . Each .06

54–25 BRISTLE STYLUS AND FIXATIVE, for use on a Tuning Fork when it is desired to record the vibrations on a smoked or coated plate or drum 25

VARIABLE SPEED AND MULTIPLE RECORDING KYMOGRAPHS AND RECORDING DRUMS

With Invisible Non-Projecting Thread Feed



Nos. 54–30, 54–35 and 51–75

Patent Pending

No. 54–40

It has been our purpose in this design to produce an instrument capable of a great variety of uses and of the very highest grade. It may be obtained, operated either by clock movement or arranged for both hand and belt drive.

The cylinder is 12½ centimeters in diameter by 16½ centimeters long, and has a lateral movement of 16 centimeters on a screw with thread so cut and mounted that the shaft does not extend beyond the bearings more than is shown in the illustration.

Ample room is provided for the simultaneous use of four tuning forks or six recording pens. One may, therefore, make records of six different operations, no matter where located.

FEATURES, —

1. Frictionless rollers on which the shaft is rotated.
2. The cylinder is mounted so that it may be given a revolving and horizontal movement along the shaft without the shaft extending beyond the bearings more than is shown in the illustration.
3. The upright supports are adjustable forward and backward on a lathe rest support.
4. Vertical adjustment is simplified by means of a clamp and a series of notches in the uprights giving a rigidity and range not found in any other instrument of this class.
5. Screws of different pitches may be obtained for the purpose of adapting the forward movement to the nature of the record desired.

54–30 **VARIABLE SPEED KYMOGRAPH** with **Clock Drive** and **Invisible Feed.** With this clock drive two speeds are possible, the change secured by meshing gears in or out, — one revolution in twenty-four hours or one in twelve hours. Clock movement is a standard high grade eight-day movement especially adapted to this kymograph. Without tuning fork and marker **$47.50**

54–32 **VARIABLE SPEED KYMOGRAPH** for **both Hand** and **Belt Drive.** Speed may be regulated within the limit of the motor or of the relative sizes of the pulleys. Without tuning fork and marker . . **35.00**

54–35 **KYMOGRAPH TIME MARKER.** This marker is much the same as ordinarily supplied for Kymograph work and is modified to the extent, only, of securing a better continuous record **6.50**

54–37 **KYMOGRAPH RECORD SHEETS** for use with Nos. **54–30** and **54–32** Kymographs. Divisions represent ten or five-minute intervals. . . . . Per Fifty **2.35**

TUNING FORKS, — any form under ten inches long. See Section 51.

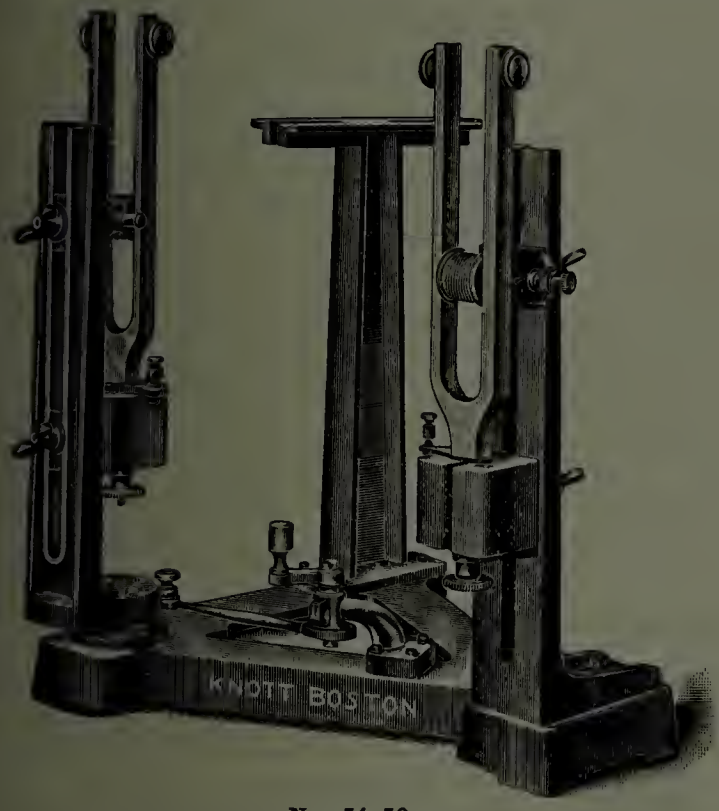
54–40 **CLOCK RECORDING KYMOGRAPH.** This instrument was designed, at the request of Dr. Bovie of Harvard University, to provide a simple easily manipulated, effective device for recording the curve of plant growth in conjunction with the Bovie Auxanometer.

The recording mechanism, whether it be a pencil or electrical pen, is readily clamped to the supporting upright as indicated in the illustration. The clock mechanism mounted in the base is a standard twenty-four hour clock movement of heavy construction.

The cylinder is raised to the upper position by simply releasing the compression clamp and lifting the cylinder bodily. The range of movement and the length of the cylinder is such as to permit three or four records being made at one time. This is made possible because of the position in which the cylinder is mounted, the weight of the cylinder assisting rather than retarding the clock movement.

Complete with twenty-four-hour movement **22.25**

LISSAJOUS' CURVES APPARATUS



No. 54–50

54–50 LISSAJOUS' CURVES APPARATUS, IMPROVED MODEL, for demonstrations of parallelly and vertically combined vibrations.

Mounted on a heavy metal base are the supports for the fork holders,— one to support the fork in a horizontal position and the other two in a vertical position, one of the latter capable of being turned backward and forward by means of a small crank.

The forks supplied with the apparatus are 250 millimeters in length and have a vibration frequency of 128 V.P.S. They are substantial in structure and especially designed to give a continuous vibration of large amplitude. Each fork is kept in vibration by electro-magnets with which each carrier is supplied. By means of two riders which are furnished with the apparatus the pitch of a fork can be slightly changed for causing beats.

With addition of a Projection Lantern and a Lens, the curves can be projected very beautifully on a screen.

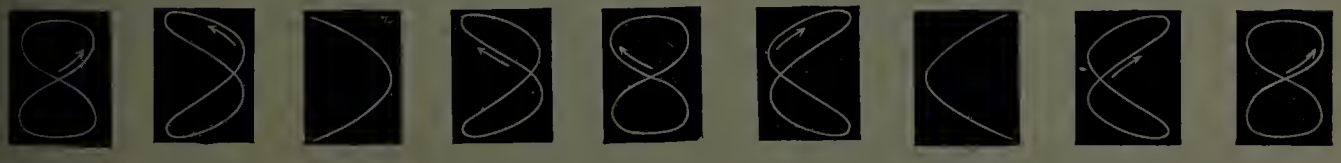
Apparatus complete with two forks . . . . . .Duty Free . . .

54–55 LISSAJOUS' CURVES APPARATUS, same as above, but without the movable upright and crank adjustment. Complete with two forks . . . . . Duty Free . . .

Luminous images on the screen when the Tuning Forks are in unison.

0 1/8 1/4 3/8 1/2 5/8 3/4 7/8 1

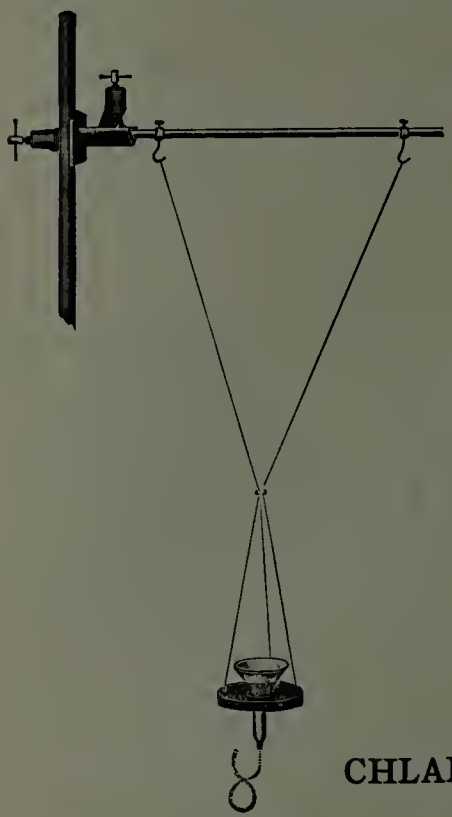
Luminous images when the difference between the Tuning Forks is an octave.



0 1/8 1/4 3/8 1/2 5/8 3/4 7/8 1

Luminous images when the numbers of vibrations are as 3:4.

0 1/24 1/12 3/24 1/6 5/24 1/4 7/24 1/3



No. 54-90

54-90 Y PENDULUM (SAND PENDULUM). This pendulum consists of a heavy bob suspended by two cords, sliding along which is a small brass ring the office of which is to vary the length of the stem of the Y, thus modifying the conditions upon which the relative phases and amplitudes depend. As this bob vibrates, fine sand contained in the funnel-shaped reservoir is allowed to trickle forth, thus tracing the path of the vibrating pendulum.

If the bob vibrates in the plane of the paper, the effective length is from the adjustable brass ring to the bob; if it vibrates at right angles to this plane, it is the distance from the support rod to the bob. The periods, therefore, will be different and independent. By adjusting the two lengths by means of the ring, the bob may be made to describe various Lissajous' Figures.

Y Pendulum only without support of any kind **$0.90**

CHLADNI'S FIGURES APPARATUS

Nos. 54-126 to 54-134

Nos. 5-1000 and 5-1085

No. 54-142

Vibrating Plates contain nodal lines which vary in number and position according to the form and size of the plate and the point at which they are set in vibration. We list below two forms of plates, each form in two sizes. We also list three different types of clamps, either of which will be found well adapted for use with any of the plates. For those teachers who are provided with T-Beam Basic Clamp No. **5-1000,** Interlocking Clamp Attachment No. **5-1085** will be found the best.

54-126 ROUND CHLADNI'S PLATE, 6 inches diameter **$1.30**

54-128 ——, 10 inches diameter **1.65**

54-133 SQUARE CHLADNI'S PLATE, 6 inches square **1.30**

54-134 ——, 10 inches square **1.65**

5-1085 CHLADNI'S PLATE INTERLOCKING CLAMP ATTACHMENT for use on our No. **5-1000** T-Beam Basic Clamp "A" . . . . . **.60**

5-1000 HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "A" . . . . . **.94**

54-141 CHLADNI'S PLATE CLAMP, common type . . . . . **.75**

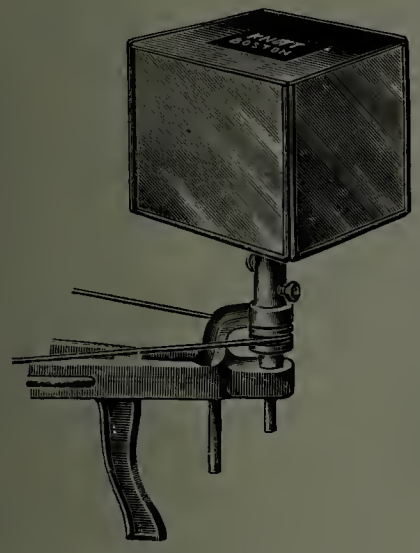
54-142 ——, large size for plates up to 10 inches **1.95**

54-145 LYCOPODIUM POWDER for use in Kundt's Tubes and on Chladni's Plates. Before using this powder, we recommend that it be thoroughly dried for best results. Per four-ounce carton . . **.45**

54-147 SAND for use on Chladni's Plate. This is the best quality fine-grained sand carefully sifted. Per eight-ounce carton . . . . . **.22**

57-20 DOUBLE-BASS BOW, recommended for exciting Chladni's Plates **1.35**

MANOMETRIC FLAME APPARATUS



No. 21–290

No. 21–295

54–165 **MANOMETRIC FLAME APPARATUS** for analysis of sound. Composed of No. **21–295** König's Manometric Flame Capsule and No. **21–290** Cubical Mirror. The latter, in use, must be attached to the socket of a rotator. The Manometric Capsule is constructed of a two-part casting assembled with the sensitive diaphragm between. To one casting is attached the tube and mouth-piece, to the other the jet and gas tube, the latter attached to a base forming the support. The cubical mirror consists of a metal box to the sides of which are fastened mirror plates. To the lower side of this box is attached a spindle to fit the socket of the rotator.
Apparatus complete, as illustrated, but without Rotator **$5.90**

21–290 **CUBICAL MIRROR,** as used in No. **54–165** **3.15**

21–295 **KÖNIG'S MANOMETRIC FLAME CAPSULE** complete, as illustrated above **2.75**

For **ROTATORS,** see Section **21.**

54–180 **MANOMETRIC FLAME APPARATUS** for analysis of sound.
This apparatus is similar to No. **54–165,** but of simpler construction. The revolving mirrors are set in brass frame fitted with spindle for revolving by hand. A simply constructed Manometric Flame Capsule is supplied with rubber tube and mouth-piece.
Manometric Flame Capsule, complete with Mirror **4.40**

21–300 **REVOLVING MIRROR WITH POSITIVE SPEED GOVERNOR.** To meet the repeated demands for a mirror which may be revolved at varying speed and of a size sufficiently large for ordinary laboratory work we have, after considerable experimentation, perfected the design illustrated.

No. 21–300

This mirror is self-contained in that the rotating power is contained in the base in the form of a small motor, with "start" and "stop" key. We secure a positive speed, governed by means of a simple, effectively operating device noted above the mirror shaft and a centrifugal governor mounted within the mirror case. We are able to secure with this structure speeds varying from a few revolutions per minute up to 2,000, — the maximum speed of the motor. This variation in speed may be made during the revolution of the mirror simply by a movement of the screw over the axle.

As may be noted, this design consists of a metal housing which serves also as a substantial base. Cast to this housing is an upright with projecting arm. The mirror is mounted in metal castings carefully centered. The metal housing is provided with binding posts for connections to the motor and also with "start" and "stop" key. The whole is finished in nickel and black oxidized, presenting a handsome appearance. It will be found efficient for all general work for which a rotating mirror is used **$9.75**

No. 21–300 (Sectional View)

GRAPHIC ANALYSIS OF SOUND WAVES

No. 54–200
"SONOGRAPH"

No. 54–200

No. 21–300

54–200 "SONOGRAPH." The instrument above illustrated will show in a superior manner all that the manometric flames will show and, in addition, many other interesting experiments. Results are easily obtained, and both simple and complex tones are readily analyzed into their various wave forms, a pure tone depicting in a striking manner the fundamental sine wave.

The operation of the "sonograph" depends on the compression and rarefactions set up in the air by sound — a spoken word, a note from an organ pipe, a tuning fork, etc., etc. These compressions and rarefactions are communicated to a diaphragm which is set in vibration, the vibrations being greatly magnified by a small mirror, the amount of movement being indicated by the tracings of a spot of light on the screen. These tracings will take the form of waves if the spot of light be first directed on a rotating mirror. This rotating mirror should be placed between a lens and the screen. Our No. **21–300,** illustrated above, described in Section **21,** has been especially designed for this work. The speed is ingeniously governed for either very high pitch or very low pitch without stopping the motor which rotates the mirror.

To secure the most satisfactory results a strong source of light will be necessary. Sunlight is, of course, the best and when used, a "pencil" of light secured through a small aperture will be found most effective. When a projection lantern or any strong artificial source is used, a system of lenses should be provided to render the rays parallel. With a good arc light or light from the sun, the waves may be easily shown to five hundred students.

The waves illustrated below are photographic reproductions taken on a revolving film.

a e i o u

Wave Forms of Vowels.

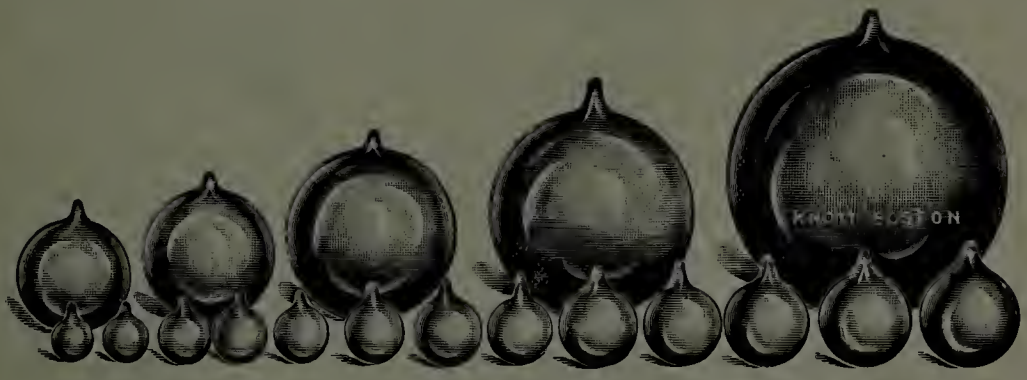
Wave Form of Vowel e.

"SONOGRAPH" only, without lens, mirror, etc. **$25.00**

21–300 ELECTRICALLY OPERATED ROTATING MIRROR, designed especially for use with "Sonograph." For description see Section **21** **9.75**

RESONATORS

No. 55–10



No. 55–32

55–10 BELL and ADJUSTABLE RESONATOR.
The apparatus consists of a Bell 15 centimeters in diameter which may be mounted on a stand. The Resonator consists of a brass tube with close-fitting sliding piston. This tube is of sufficient length to respond to all notes above 256 V. P. S.

Complete as illustrated, with Bell, Resonator, and Stand, but without plate **$3.15**

BRASS HELMHOLTZ RESONATORS. These Resonators are thin brass globes, with wide orifices at one side to receive the exciting waves and narrow orifices to conduct the vibrations to the ear. They are accurately made, neatly polished and lacquered. Fundamental tone, low C = 64 V. P. S.

55–30 HELMHOLTZ RESONATORS, set of eleven . . . . . Duty Free . . .
55–32 ——, set of eighteen . . . . . Duty Free . . .
55–34 ——, set of twenty-five . . . . . Duty Free . . .

No. 55–45

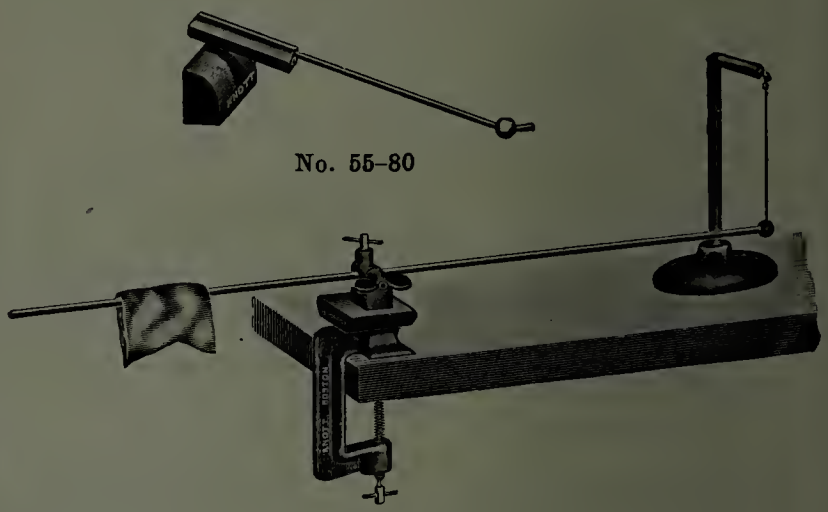
No. 55–60

55–45 GLASS HELMHOLTZ RESONATORS for the analysis of sound, consisting of a set of four glass globes each with a wide orifice at one side to receive the exciting waves and a narrow orifice at the other side to conduct the vibrations to the ear. Will respond to the notes C_5, E_4, C_4, and G_3 . . . **$11.50**

55–60 ACOUSTIC REACTION WHEEL for illustrating Acoustic Repulsion.
The apparatus consists of four glass resonators fixed upon arms and centered to pivot on a stand. In use, the repulsion is so strong as to produce uniform rotation.

Complete as illustrated **9.75**

No. 55–70



No. 55–80

No. 55–75

55–70 VIBRATION APPARATUS for showing that sound propagates rarefactions and condensations in the surrounding media.

This apparatus consists, as illustrated, of two circular discs over one face of which is attached a plate. Suspended so as to rest against the plate of one is a small ball which is used as an indicator of the sound wave. If now the plate of the second is struck a sharp blow by means of the small hammer, vibrations set up will be communicated in waves to the first, causing the small ball to dance.

This is a very striking experiment and can be used to advantage in wave study **$8.25**

55–75 VIBRATION OF ROD APPARATUS for illustrating the vibration of a sounding rod.

The apparatus consists of a centrally clamped brass rod, one end of which is stroked by resinous cloth or set in vibration by other means. Suspended to an upright frame in bi-filar suspension is a light sphere which is adjusted so as to rest against one of the free ends of the rod. Any vibration, therefore, set up in the rod is communicated to the ball, causing it to rebound from the end of the rod.

Apparatus complete as illustrated, without Basic Clamp **2.20**

55–80 TREVELYAN'S ROCKER for illustrating that musical vibrations are maintained by communication of heat.

The apparatus consists of a brass rod with a V-groove milled lengthwise. To this rod is fastened a metal handle with ball end. When this bar is heated at some point below the melting point of lead and placed so that the edges of the V-groove rest on the lead casting as illustrated, the bar begins to rock, emitting a harsh note. This note may be made to rise in pitch by slightly pressing on the bar.

Trevelyan's Rocker with Lead Rest **2.00**

55–115 TYNDALL'S TUBE for illustrating the transmission of sound in air by wave motion.

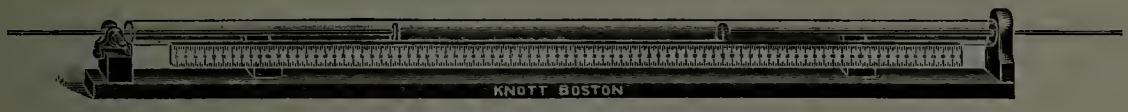
This apparatus consists of a thin metal tube built in sections to three meters in length, the end section terminating cone-shaped. In use this tube is mounted on a simple wooden support. If a lighted candle is placed in front of the conical orifice, and a sharp sound such as that emitted by the clapping together of two sticks is made at the other orifice, the wave motion set up by the sound will be transmitted throughout the whole length of the tube, causing such a disturbance at the conical orifice as to put out the candle flame **2.95**

21–280 CROVA'S DISC AND SHIELD for illustrating the compressions and rarefactions caused among air particles by a sound wave. See Section **21** **2.45**

WAVE MOTION APPARATUS. SECTION 26.

VELOCITY OF SOUND

KUNDT'S APPARATUS



No. 56–20

No. 56–30

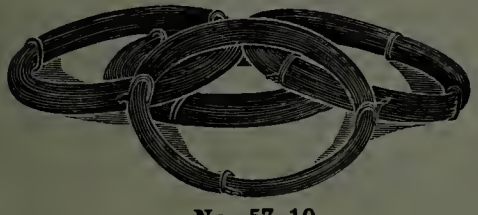
56–20 KUNDT'S APPARATUS for demonstrating vibrations in a tube closed at both ends; also for measuring the velocity of sound in air.

The apparatus consists of a resonance tube, 110 centimeters in length, closed at one end by a tight piston and near the other by a loose-fitting piston at the end of a brass rod. This brass rod, in use, is firmly clamped in a vise. The tight-fitting piston is adjustable within the tube by means of a rod. The whole is compactly mounted on a neat support.

Complete as illustrated $3.65

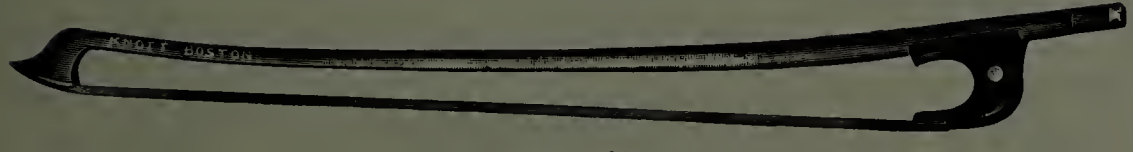
56–30 KUNDT'S APPARATUS, with fittings for the introduction of various gases for the measurement of the velocity of sound in different gases 8.60

MISCELLANEOUS SUPPLIES



No. 57–10

No. 57–25



No. 57–20

57–10 PIANO WIRE, best quality imported, wound in coils, each weighing approximately ¼ pound.

	a	b	c	d
Diameter, inch . .	.028	.022	.0178	.014
Per Coil	$0.40	.45	.45	.55

57–20 DOUBLE-BASS BOW for setting sounding bodies in vibration.

This Bow is substantially constructed with a heavy wooden frame. Length 27 inches $1.35

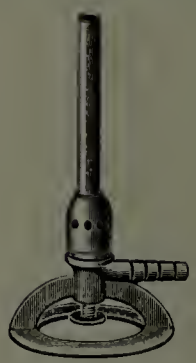
57–25 RESIN for use on bows and rods. Best quality French resin. Per cake, in cardboard box 06

HEAT

GENERAL APPLIANCES FOR HEAT EXPERIMENTS

BUNSEN BURNERS

Our selection of **BUNSEN BURNERS** from the many designs on the market, has been based upon greatest laboratory utility. Thus, there will be found in this list only burners which have given entire satisfaction and which have shown, from experience, that they are well worthy a place in this edition of our catalogue. Each burner is carefully constructed and rigidly tested. The finish is durable, and designed to withstand rough usage and the corrosive action of chemicals in the chemical laboratories. We have given a considerable latitude for choice, and there will be found in this list burners to meet every need.



No. 60–10

No. 60–12

No. 60–17

No. 60–20

60–10 **NORMAL BUNSEN BURNER** for gasoline or illuminating gas, with both gas and air regulation . . **$1.00**

60–12 **HARVARD BUNSEN BURNER,** with regulation for both gas and air; tube with threaded top for screwing on of star for holding a chimney, a fine adjustment support . . . . . **.75**

60–17 **PILOT LIGHT BUNSEN BURNER** for gas. Screw regulation for pilot, stop-cock for shut-off, air regulator. Excellent where intermittent flame is required. Tube ½ inch in diameter **2.25**

60–20 **SCHOOL BUNSEN BURNER,** a serviceable gas burner with air regulation; diameter of tube ½ inch **$0.25**

60–23 **CENTRAL DRAFT BURNER** with air regulation . . . . . **.20**

60–25 **BURNER WING TOP** for producing a hot, smoky, wide flame, advisable in bending glass tubing . . . . . **.15**

No. 60–27

No. 60–30

No. 60–35

60–27 **LOW FORM BUNSEN BURNER,** upward curved tube, air regulation, height 3 inches, diameter of tube $\frac{7}{16}$ inch **$0.50**

60–30 **GILLEY LOW FORM BUNSEN BURNER,** as regularly used with our Standard Hypsometer No. 60–350 . . . . . **.40**

60–35 **ACETYLENE GAS BUNSEN BURNER,** operating efficiently, giving an intense flame. Diameter of tube $\frac{9}{16}$ inch **1.25**

60–38 **ANTIMONY RUBBER TUBING** for burner connections. This is the best quality antimony tubing, made for the past seventeen years from our own formula.

	a	b	c
Inside diameter, inch . .	$\frac{3}{16}$	¼	$\frac{3}{8}$
Per Foot	$0.08	.12	.17

MISCELLANEOUS BURNERS
BLAST LAMPS

No. 60–40

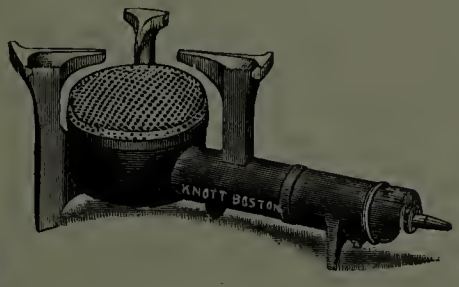
No. 60–45

60–40 **SEMI-BLAST WYNNE BURNER,** supplying either a very hot Bunsen flame or a semi-blast, — in some respects preferable to the ordinary blast flame.
This burner, substantially constructed of brass and iron, has regulations for both gas and air. Perfect combustion is insured. Air adjustment is secured by regulation of height of tube, gas adjustment by a screw. Possibility of adjustment of flame to any position is also a highly appreciated feature of this burner $1.50

60–45 ——, similar to above, but adjustment for flame direction is limited 90

NOTE. — The general form of this burner has been copied by other houses, who are making it of much lighter material, the adjustments of cheaper construction and with no apparent attempt to reproduce the form of the inner gas chamber which has made this burner so efficient.

No. 60–80



No. 60–75

No. 60–100

No. 60–110

60–75 **SOLID BUNSEN FLAME STOVE.** The advantage of this burner is a broad flame of uniform temperature. It is especially desirable for heating water in quantities; also for rapid heating of No. **60–365** Hypsometer $2.90

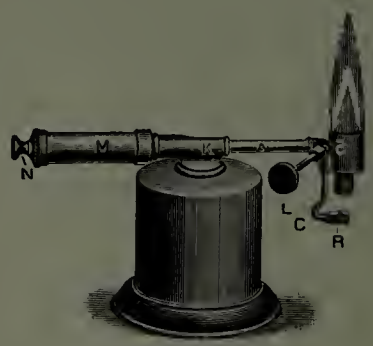
60–80 **INSTANTANEOUS HOT WATER HEATER.** This apparatus consists of a coiled copper tube enclosed in a Russia iron case. Cold water enters at one end of tube; hot water is delivered at the other end, — instantaneous in action. Illustration pictures apparatus complete with above stove.
Complete with Burner 9.50

60–81 **INSTANTANEOUS HOT WATER HEATER** without Burner 6.60

60–100 **POLISHED COPPER ALCOHOL BURNER,** capacity two ounces.
This is a small, highly appreciated burner giving a very hot flame.
With ground-on cap, wick, and wick-holder 75

60–110 **ALCOHOL BURNER,** glass, capacity 8 ounces.
Complete with ground-on cap, wick, and wick-holder 38

No. 60–120



No. 60–135

No. 60–150

No. 60–160

No. 60–275

No. 60–300

60–120 **HOT-BLAST ALCOHOL STOVE.** This is a compact stove weighing only 5 ounces. Its efficiency is remarkable. In actual tests water has been heated to boiling point from 0 degree Centigrade in 12½ minutes.

We have no hesitancy in recommending this stove for general use in laboratories not connected with gas.

Complete as illustrated, with tripod support . . . . . $ 0.25

60–121 ——, same as above, without tripod support 18

60–135 **GASOLENE BURNER.** This burner meets all the uses of a Bunsen burner. It is practically automatic in its action, generating its own gas. Air pressure is obtained by small force-pump contained in the handle. Flame is adjustable from very small height to 5 or 6 inches, and will burn for 1¼ hours at full blast from one filling of the reservoir, which holds about ½ pint of gasolene and with one pumping of air pressure 3.65

60–150 **BUNSEN BLAST LAMP,** stable and durable in construction, capable of the most exacting service. Will produce the maximum intensity of heat with the minimum consumption of gas. Both air and gas pipes supplied with stop-cock 3.50

60–160 **DOUBLE CONCENTRIC BUNSEN BLAST LAMP** for illuminating gas only.

This type of lamp has an inner air jet and an inner tube which may be used either for air or gas, and an external gas tube. The gas and air are changed automatically from the larger to the smaller tube by a slight movement of the lever at the back, the same movement also adjusting both gas and air to each other for each tube. This combination of practically two blowpipes gives a great range of power from a small-pointed jet to a brisk flame, using approximately 35 feet of gas per hour 10.00

60–275 **FOOT BLOWER** for Blast Lamp, Blowpipe, and similar work.

This is a substantially constructed blower of the latest pattern, with iron legs, producing a steady, powerful blast. Diameter of air reservoir, 9 inches; blast pressure per inch, 1½ pounds; cubic feet of air per hour, 330 . . . . . 8.75

60–300 **HAND BELLOWS.** This is a simple inexpensive blower, width 7 inches, capable of efficient service where a not too powerful blast is required 1.00

HYPSOMETERS

No. 60–350

No. 60–365

60–350 GILLEY STEAM BOILER or HYPSOMETER for general use in heat, in generation of steam, in determining the boiling point of a thermometer, or for use where steam is required for the proper conduct of an experiment.

The apparatus proper consists of a carefully constructed copper boiler mounted on three legs. This boiler is constructed of best quality of material, all joints being sealed in a manner to obviate the danger of destruction due to careless overheating. Entering the sides of this boiler are three tubes, two of which are connected by rubber and glass tubing for showing the water level, the third for attachment of the pressure gauge. The top of this boiler is provided with a screw to which may be attached the screw cap when it is desired to use the boiler merely as a steam generator. This screw must be replaced, however, by a thermometer tube in using the apparatus in determining or in testing the boiling point of a thermometer. In specific heat experiments, this tube is replaced by the dipper in which the solid is heated.

The apparatus is furnished complete as illustrated without Pressure Gauge or Burner, but including the Steam Boiler, Screw Cap, Thermometer Tube, Dipper, and Water Gauge.

This form of Hypsometer is recommended for its compactness, stability, and rapidity of heating and ease with which thermometer readings may be made.

The tall form of apparatus brings the reading portion of the thermometer scale so high that many students are not able to make accurate readings without the use of a stool or some other means of bringing the eye to the right position. The errors of parallax, almost unavoidable in the use of the tall form, are a serious drawback to its use $2.75

60–30 GILLEY LOW FORM BUNSEN BURNER, as illustrated in No. **60–350** above 40

60–100 POLISHED COPPER ALCOHOL BURNER, capacity 2 ounces, giving a very hot flame. Advised for use with No. **60–350** when laboratory is not equipped with gas 75

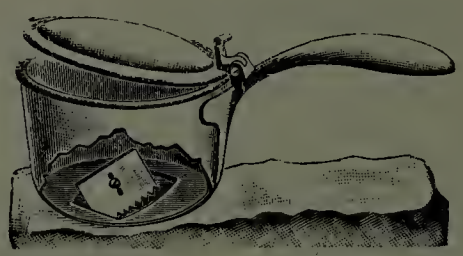
60–365 STEAM BOILER or HYPSOMETER, as designed by G. M. Turner.

This form of Hypsometer has received the same careful attention in design and details of structure as our No. **60–350.** Its design was first suggested to fill the demand for a hypsometer the steam boiler of which could be detached from the tripod support and which could make use of the ordinary type of Bunsen burner. As may be noted from the illustration, our design fulfils these requirements. This form has the further advantage over our No. **60–350** in that it may be used on a stove similar to our Nos. **60–75** and **60–120,** the stoves in these cases answering the purpose of the tripod support.

Complete as illustrated, with tripod support, steam boiler, screw cap, dipper and thermometer tube 2.95

60–390 IMPROVED FORM PRESSURE GAUGE, especially adapted for use with Hypsometer No. **60–350,** on which instrument it will be found illustrated 11

No. 60-400



No. 60-440

No. 60-430

No. 61-10

No. 61-11

60-325 **POLISHED COPPER BEAKER,** of heavy polished copper, of extreme utility in a great number of experiments requiring the use of an indestructible utensil for boiler, etc. Capacity 500 cubic centimeters $0.90

60-330 **POLISHED ALUMINUM BEAKER,** similar to above, 500 cubic centimeters capacity 1.00

60-400 **WATER TRAP, IMPROVED DESIGN,** essential in determining the latent heat of steam by preventing any condensed steam passing into the calorimeter.
Our design has been improved by the short curved end which entirely obviates any danger of condensed steam passing through into the calorimeter 35

60-405 **H-K STEAM TRAP,** consisting of bottle with glass tubes and stopper arranged to catch any condensed steam as it passes through the bottle 45

60-430 **GALVANIZED IRON ICE TRAY,** designed especially for cooling dry air enclosed in Charles Law Tube. With tubulature as illustrated 75

60-435 **CANVAS ICE BAG** for crushing ice into small fragments for calorimetric determinations 17

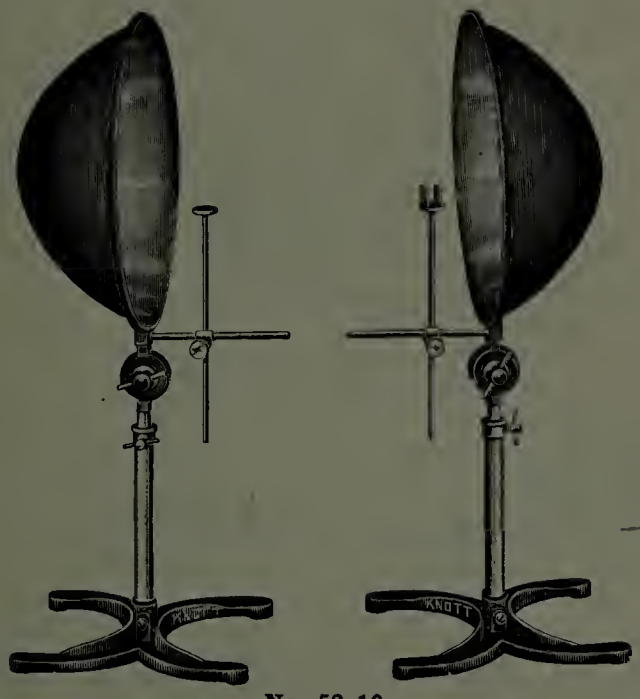
60-440 **ICE SHREDDER and SHAVE,** coarse or fine shavings 1.25

RADIATION, REFLECTION, CONDUCTION CONVECTION

61-10 **CROOKE'S RADIOMETER,** illustrating attraction and repulsion arising from radiation.
This instrument consists of a very light vane constructed of thin mica discs fastened at the ends of four arms of aluminum wire, the whole arranged to turn very freely about a vertical axis and enclosed in a glass vessel which is highly exhausted. Each of these mica discs is blackened on one side. On exposing the Radiometer to any source of radiant heat the vane revolves in such a direction that the blackened faces are always receding.
Mounted on glass foot $1.55

61-11 **CROOKE'S DOUBLE RADIOMETER,** similar to above, but with two bulbs, in each of which is mounted a vane pivoted independently with its blackened faces opposite to each other.
Mounted on glass foot 4.00

PARABOLIC REFLECTORS



No. 52-10

52-10 THIRTEEN-INCH UNIVERSALLY ADJUSTABLE TRUE PARABOLIC REFLECTORS, for demonstrating Reflection of Sound, Heat and Light Waves.

In offering for sale our Improved Reflectors we desire to emphasize the **TRUE PARABOLIC SURFACES.** The curves of these surfaces have been accurately calculated and then by painstaking processes a chuck has been turned to the true parabolic curve. Our Reflectors are all spun from this chuck. The reflecting surface is then highly polished and heavily nickel-plated, presenting an excellent surface without waves.

The Reflectors are mounted in a two-part circular casting in such a manner as to entirely obviate any danger of distorting the surfaces. This two-part casting is brought together at the bottom, where it makes a swivel junction with a rod which telescopes into the supporting base.

The Holders and Attachments are all of special design which allows of both coarse and fine adjustments. We, therefore, secure a tilting movement for the Reflectors, an adjustment for proper height, and universal movements for each attachment.

In demonstrating reflection of heat waves either a candle or a heated metal ball may be used in one of the Carriers at the focus of one reflector; if now a piece of phosphorus be placed at the focus of the other reflector in its Carrier, the heat waves brought to a focus will cause the phosphorus to burn.

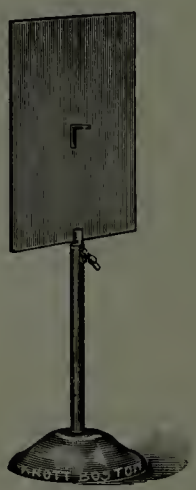
The finish of this instrument is fully in keeping with the design. The outer surfaces of the reflectors are dull oxidized, the H-Base japan, and all brass parts polished and nickel-plated.

Thirteen-inch Universally Adjustable True Parabolic Reflectors complete as illustrated with Attachments . . . . . .Per Pair **$17.50**

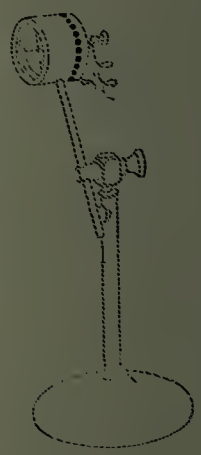
52-15 THIRTEEN-INCH UNIVERSALLY ADJUSTABLE TRUE PARABOLIC REFLECTORS, same as above, mounted on stand but without Attachments or Carriers . . . . . Per Pair **13.50**

ABSORPTION — RADIATION SCREENS

No. 61–70



No. 61–75



No. 61–100

61–70 ABSORPTION SCREEN for the comparative illustration of the absorptive power of two different substances.
This is a screen of polished metal with ring of black painted on face, and the back coated with red mercuric oxide.
If a source of radiant energy is held in front of the face, a ring will be reproduced in yellow on a red ground on the back of the screen. As the mercuric oxide turns yellow at 150 degrees Centigrade, it may be concluded that a black surface has more absorptive power than a polished surface . . **$2.85**

61–75 RADIATION SCREENS for comparative illustration of the absorptive power of two different substances.
This apparatus consists of a pair of screens, 10 inches square, one of polished metal, the other of metal with the face blackened, each screen with small ledges at the back for pieces of phosphorus.
When placed facing source of radiant energy, it will be noted that the action upon the phosphorus is immediate in the case of the blackened screen, whereas the energy is deflected on the polished screen, demonstrating the absorptive power of a blackened surface and the reflecting power of the polished surface . . . . . Per pair **4.25**

61–100 LESLIE'S CUBE for the comparative illustration of the emissive powers of different substances.
This is a hollow metal cube, 2½ inches on an edge, one face polished, the other three coated with different substances which have different emissive powers. A tubulature is provided at top for introduction of hot water and then, if desired, for a thermometer.
When these surfaces are allowed to radiate in succession against the face of a thermopile or other delicate radiometer, it will be noted that the indications vary, showing the polished metal a very poor radiator, the other substances varying in emissive powers.
Leslie's Cube only, without Thermopile and without Stand, with three-sided protective case . . . **1.35**

61–105 ——, with four polished faces, each of different metals **$1.65**

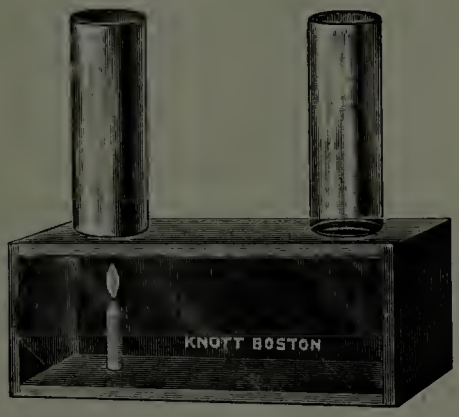
THERMOPILES. For illustration and description see Section **64**.

64–15 DIFFERENTIAL THERMOMETER, frequently desired in connection with Leslie's Cube. For illustration and description see Section **64** **7.50**

61–135 COOLING CUP, after Turner and Hersey (Experiment No. **H100**), for comparing the rate of cooling of different substances.
The apparatus consists of two cooling cups, one nickel-plated, the other blackened, with two wooden covers each with hole for thermometer.
In use, each is supported in the ring of a Ring Stand on Wooden Support Ring. Hot water is poured into each and curve of rate of cooling is determined by the reading of the thermometers.
Apparatus complete, with two Cups, one nickel-plated, the other blackened, two Support Rings, and two Covers **1.65**

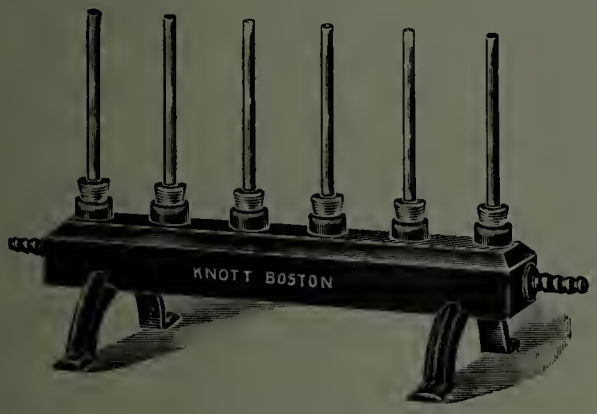
No. 61–135

No. 61–150



No. 61–160

No. 61–178



No. 61–175

No. 61–180

No. 61–185

CONVECTION OF HEAT

61–150 **CONVECTIONAL CURRENT APPARATUS** for illustrating Convectional Currents in Liquids. When the tube is heated in the lower part, currents are set up. These currents will be readily noted by introduction of a few grains of cork dust or addition of some aniline dye $1.15

61–160 **CONVECTIONAL CURRENT APPARATUS** for illustrating Convectional Currents in Air. By placing a burning candle in the box under one of the chimneys, convectional currents are set up, as may be demonstrated by use of burning Touch Paper or other smoke producers, at the open end of the other chimney. Without candle 1.90

61–161 **CHIMNEYS,** straight form . . . . . Each .15

70–50b **CANDLES,** twelves (12 to the pound) . . . . . Per dozen .20

61–163 **TOUCH PAPER** . . . . . Sheet .10

CONDUCTION OF HEAT

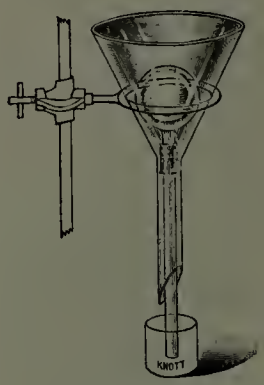
61–175 **HARCOURT COMBINATION VERTICAL CONDUCTOMETER** for illustrating relative conductivities of different solids.
This apparatus consists of a cored casting into which steam may be led from some steam generator. (See Hypsometers Nos. **60–350** and **60–365.**) The top of this casting is provided with tubulatures into which are placed the stoppers holding the different metal rods. Each rod is provided with cavities in the upper end for phosphorus and in addition is coated with a heat indicating paint . $3.90

61–178 **HEXAGONAL COMBINATION CONDUCTOMETER** for illustrating the conductivity of different metals.
This conductometer consists of a hexagonal casting, into five faces of which are threaded five rods of different material; into the sixth face is threaded a brass rod terminating in a handle. On each rod at equal distances from the faces are cavities for phosphorus. Each rod in addition is coated with a heat indicating paint 1.60

61–180 **PRIMARY CONDUCTOMETER** for illustrating conductivity of metals.
Four rods of different metals fastened to a wooden backing 35

61–183 **CONDUCTIVITY RODS,** set of three, 8 centimeters long 30

61–185 **COMPOUND ROD** for comparative conductivity illustration.
This consists of a rod, 5 inches by ½ inch diameter, part of which is wood, part brass. When heated at middle and held in hand, the relative conductivity may be readily noted 35



No. 61-195

No. 61-200

No. 61-205

No. 61-210

No. 61-215

61-195 **CONDUCTIVITY OF WATER APPARATUS,** after Millikan and Gale, Figure 198. Without stand and dish . . . . . $ 0.55

61-200 **DEWAR BULB,** illustrating the practically non-conductivity of a vacuum, designed for transporting liquid air.

This consists of a double-walled glass vessel, the chamber between walls being exhausted. Capacity 500 c.c. 3.90

61-205 **UNEXHAUSTED DEWAR BEAKER** for study of heat insulating qualities of a vacuum chamber.

This apparatus consists of a double-walled vessel with tube entering inner chamber for purpose of exhausting same 3.25

61-210 **STEEL ENCASED SOLID ALUMINUM-LINED FIRELESS COOKER.** In Manual Training Schools, Vocational Schools, and schools giving courses for young women, the Fireless Cooker has become a prominent and important feature.

It should be the design of every course in Physics to study the scientific aspects of the Fireless Cooker in its relation to questions of conduction, convection, and temperatures, and time required to produce the fundamental chemical changes occurring in the process of cooking.

This cooker is of the very best make, worked out upon a scientific basis. The radiator is of soapstone. The cooking compartments are of solid, seamless aluminum, provided with ample heat insulation. The case is of planished steel, provided with legs and castors. Size 20½ inches high, 16½ inches wide and 16½ inches long.

Furnished complete with one 12-quart aluminum kettle, two heat radiators, radiator thermometer, one radiator rack, one pair individual pastry and cake shelves, radiator hook and book of directions 16.00

NOTE. — We are prepared to furnish larger sizes than listed above. Prices on application.

61-215 **DAVY'S SAFETY LAMP,** illustrating the high conductivity of metal gauze. Valuable in mines against "fire damp," in that although an explosive mixture may burn within the gauze, the flame cannot pass through it to the gas outside 2.50

61-220 **LIQUID CONDUCTION TUBE,** illustrating the slight conduction qualities of water. Water may be boiled in upper part while ice remains unmelted at lower end 15

No. 62–10

62–10 **PAPIN DIGESTER,** illustrating the rise in boiling point by increase in pressure.

This is a strongly constructed brass boiler about 5 inches high by 3½ inches average diameter. With gasket and heavy metal cap, which may be rigidly clamped to boiler. This cap is provided with a hole for thermometer and also with a safety valve.

Complete as illustrated with Safety Valve and Weight, Tripod Support, and Thermometer $14.00

62–11 ——, similar to above, but with addition of Pressure Gauge . . . 17.50

62–15 **BOILING POINT OF ALCOHOL TUBE,** after Millikan & Gale's "A Laboratory Course in Physics," Exercise **23**, for determining the boiling point of alcohol by finding the point at which its saturated vapor pressure is equal to the atmospheric pressure.

This is a simple form of U-Tube, closed at one end. In use it is partially filled with mercury and alcohol carefully worked around into the closed arm from which the air is altogether driven. The alcohol is vaporized by immersion in a hot bath. When vapor pressure equals atmospheric pressure, the mercury will be at the same height in both arms. The temperature of the water bath at this point will be the boiling point of alcohol.

Tube only, unfilled 30

62–16 **BEVELED GLASS TUBE,** 20 cm., after Turner and Hersey Exp. H012 . . . . . $0.12

62–20 **VAPOR PRESSURE TUBE,** for determining vapor pressure and boiling point of a liquid.

This apparatus consists of a U-Tube, one branch of which is provided with stop-cock, an indispensable feature for excluding the air in the closed arm and for the introduction of the liquid; also for the proper cleaning of the tube after use 1.45

No. 62–20

No. 62–62

No. 62–50

62–50 **VAPOR TENSION APPARATUS,** for direct comparison and measurement of the vapor tensions of different liquids.

The apparatus consists of four heavy-walled glass tubes connected through a stop-cock at the top to a small reservoir. These four tubes are held by a special clamp to a metal upright supported on our H-Base. A second clamp trough casting is provided for mercury into which the open ends of the tubes dip. Each tube has an individual trough of its own, thus avoiding expense of an unnecessary amount of mercury.

Complete as illustrated with four tubes $8.75

62–51 **VAPOR TENSION TUBES,** as used in above . . . . . Each 1.50

62–53 **VAPOR TENSION APPARATUS,** similar to above, but tubes not provided with stop-cocks. Each tube is heavy walled with closed end. Complete with four tubes, supporting upright, clamp, and mercury reservoir 4.45

62–54 **VAPOR TENSION TUBES,** as used in above . . . . . Each .28

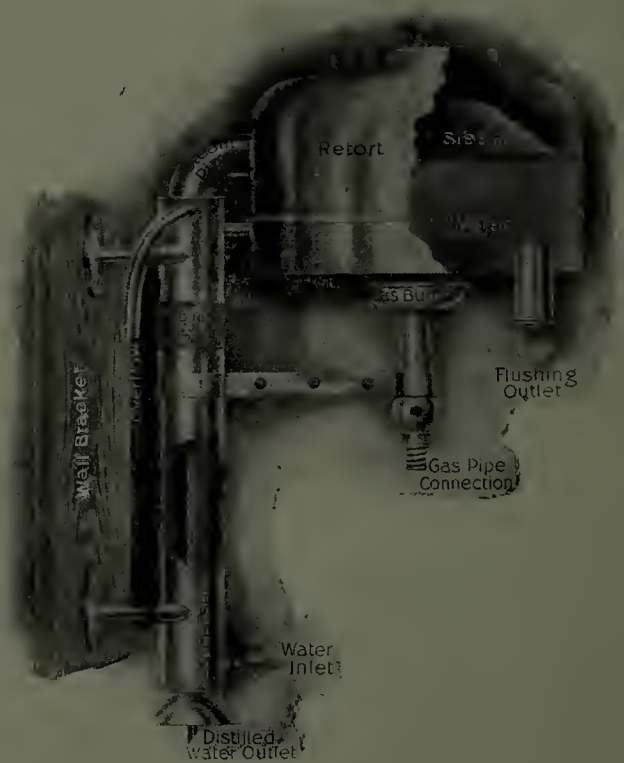
62–62 **VAPOR TENSION TUBE with CAPILLARY OF KNOWN VOLUME.** This tube may be adjustably mounted in place of air thermometer bulbs as illustrated under No. **64–55** (see Section **64**). At the upper part of the tube there are two stop cocks between which is a capillary of known volume. Most accurate determinations of vapor tension are possible with this tube. Each 3.00

VAPORIZATION, BOILING, DISTILLING, FREEZING, STILLS

No. 62–70

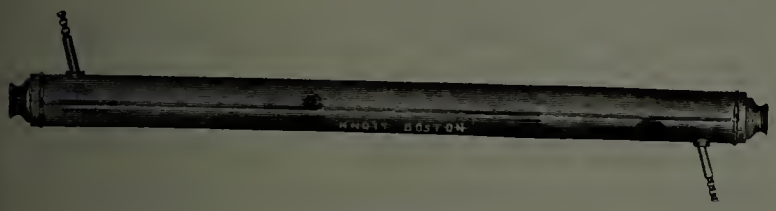
62-70 **STILL,** for distillation of water or spirits.
This apparatus consists of a heavy tin-lined copper boiler with movable head, connected with the pure block tin condensing worm enclosed in a zinc vessel, provided with proper inlets and outlets. Complete as illustrated.

	a	b	c	d	e
Capacity, gallons . .	½	1	2	3	5
Each	$10.60	12.40	14.50	19.75	26.50



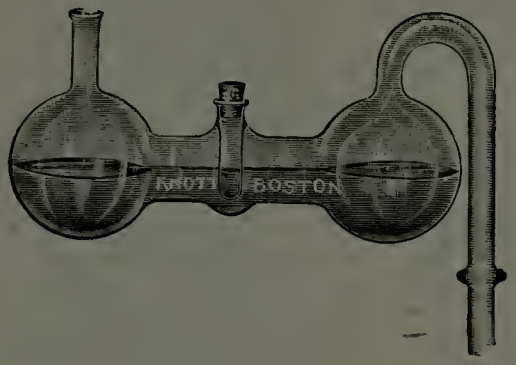
No. 62–80

62-80 **ACME WATER STILL.** This still is a perfect apparatus for the production of pure water by distillation. The distillate is cold, and aerated if desired. The apparatus is of first-class workmanship throughout and is made of copper and brass, tin-lined and nickel-plated. The gas and water connections are extremely simple. The Acme Water Still runs automatically and there is nothing to get out of order. It is started and stopped in a moment. The "Acme" is comparatively the fastest and most economical Water Still, as it produces a gallon of distilled water in about 1½ hours, at a cost of about 1½ cents per gallon. It is the most durable still, and will practically last a lifetime, as the mineral and other matter that remains in the retort is drained off through the flushing outlet, this being done in a moment without any trouble and without displacing the still or taking it to pieces. The combustion of gas with our special burner is perfect and all the heat is fully utilized. Wall space required 4 × 12 inches, extreme width 8 inches, projection 14 inches.
Still as illustrated with burner for coal or water gas, natural gas, or acetylene **$24.50**



No. 62–120

No. 62–140



No. 62–155

No. 62–150

62–90 WOODEN HEAT SHIELD, for use as insulator of heat when it is desired to shield part of an experiment from heat rays emitted from another part, especially when in calorimetry it is desired to use a steam boiler.

The shield consists of a board, mounted upright on a base. This board is provided with hole for passage of delivery tube for the steam generated in the boiler. $0.45

62–120 LIEBIG'S METAL CONDENSER, for the distillation of liquids.

This condenser is made of brass and highly polished. Length 30 inches; diameter 1 7/8 inches. This form prevents breakage 2.75

62–125 LIEBIG'S CONDENSER, entirely of glass, condensing tube fitted to jacket by rubber connection. Length 12 inches 85

62–126 ——, same as above, but 24 inches long 1.60

HARCOURT ECONOMY MERCURY STILL. See index.

62–140 FRANKLIN'S PALM or PULSE GLASS, for illustrating influence of pressure on boiling.

This glass consists of two bulbs joined by a tube which is filled with a colored liquid and from which air has been expelled as completely as possible by boiling the liquid before sealing the tube. There is then in the glass a pressure due to the elastic force of the aqueous vapor which at ordinary temperature is very small. If, now, one of the bulbs be held in the hand, the heat is sufficient to produce a pressure which drives the liquid into the other bulb and causes it to boil violently, the hand feeling also a sensation of cold 35

62–150 WOLLASTON CRYOPHORUS, illustrating freezing by evaporation.

In use, the water is introduced into the bulb on the bent neck and the other bulb is placed in a freezing mixture. The vapor then is condensed in the tube, causing the water in the bulb to evaporate rapidly in order to yield more vapor. This rapid evaporation causes the water in the bulb to freeze. Without jar 1.40

62–155 CARRE'S FREEZING APPARATUS for connecting to an Air Pump, illustrating freezing of water by its own rapid evaporation, at the same time causing ether to boil.

A few strokes of the piston of the Air Pump cause the water in the flask to evaporate rapidly. The vapor is absorbed at once by the sulphuric acid, causing more rapid evaporation of the water, at the same time increasing its own temperature to such an extent as to cause the ether to boil, and if the tube containing the ether has been lightly stoppered, causing the cork to fly out 2.15

No. 62–160

No. 62–200

No. 62–240

No. 43–310

62–160 SULPHURIC ACID CRYOPHORUS, for freezing water by its own rapid evaporation.

When the top bulb has been half filled with water and the middle bulb filled with strong sulphuric acid, the vessel should be clamped in a position as shown in the illustration. The water is then heated until about 1/3 has been driven off in steam. The lower neck is then tightly corked by means of a stopper plug covered with a piece of india rubber tubing, and the burner is removed.

The water is then cooled by immersing in a cold bath. When sufficiently cooled, the apparatus is turned round a number of times, in such a way that the acid can run in and out of the middle bulb while the water is not allowed to leave the top bulb. The heat generated by the absorption of water vapor drives out any air which may be dissolved in the acid. The stopper is removed and the boiling is continued as described above. After passing the acid several times to and from the middle bulb, the water in the top bulb will be found to solidify. Care must be taken, however, throughout the experiment to prevent any acid passing over into the water bulb, or the experiment will not be a success.

Cryophorus complete as illustrated with Stopper Plug and Delivery Tube **$1.90**

43–310 FREEZING APPARATUS, illustrating the freezing of water by the rapid evaporization of ether.

As air is exhausted from bell glass, the ether evaporates very rapidly, causing water in watch glass to freeze.

Complete as illustrated **1.40**

62–200 DEW POINT APPARATUS, after Millikan, Gale and Bishop, Exp. 10A, for determining the temperature at which water vapor begins to condense out of the atmosphere as the temperature is lowered.

In use, the metal tube is filled two-thirds full with ether. Air is forced very gently through this ether by means of the bulb. This process facilitates cooling, since it increases the evaporating surface. The temperature existing within the tube when the first cloudiness begins to appear upon the polished surface is the Dew Point.

Complete as illustrated . . . . . **.95**

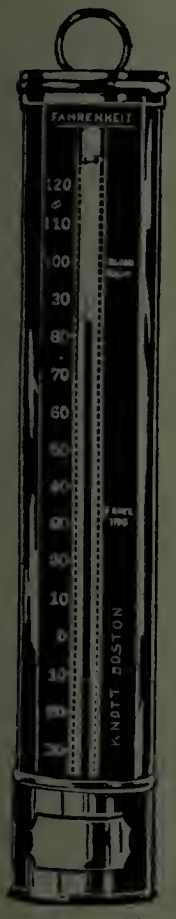
62–225 MELTING POINT TUBE, for determining the melting point of paraffine, wax, and other substances which, when in solid state, have a color but which turn colorless in liquid state.

This tube consists of a glass tube with end bent and drawn to a point. While hot, the substance is drawn into the tapered point. It is then allowed to cool when it is immersed into water, the temperature of which is gradually increased until the substance loses color, when temperature is noted by thermometer. This reading will be the melting point of the substance . . . . . **.15**

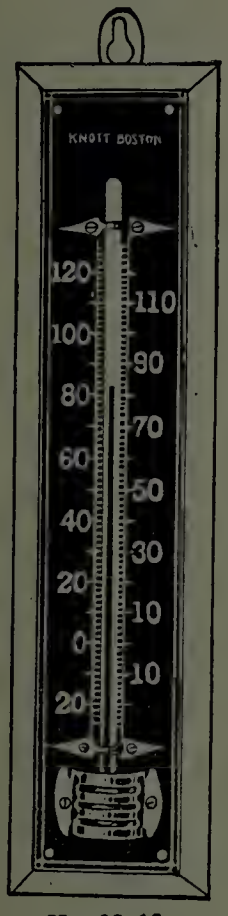
62–240 CUBICAL EXPANSION BULB, for determining the point of maximum density of water. This apparatus consists of a bulb of known volume with graduated capillary neck.

When filled with water, sufficient to fill the bulb and three quarters of the graduated neck, the bulb is immersed in water, the temperature of which is taken. Freezing mixture is added to bath and continuous readings of thermometer and graduated neck are taken. A point will soon be reached where the reading on the neck does not descend as the temperature decreases but at this point will begin to rise, showing that this is the point of maximum density. This point will be found at about 4 degrees Centigrade **1.10**

MEASUREMENT OF INTENSITY OF HEAT
THERMOMETERS



No. 63–10



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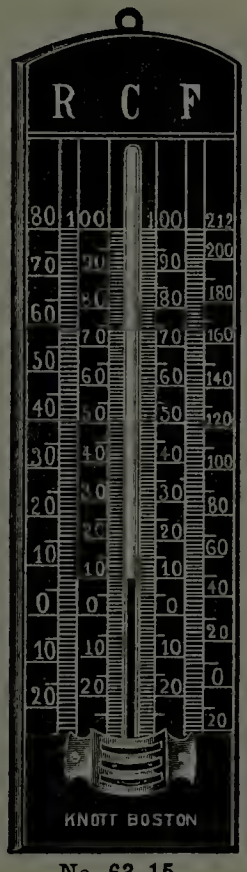

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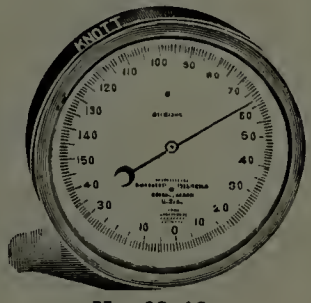


No. 63–18

No. 63–20

63–10 HOUSEHOLD THERMOMETER, 8 inches long, heavy metal frame, reading from –30 degrees to 120 degrees Fahrenheit **$0.60**

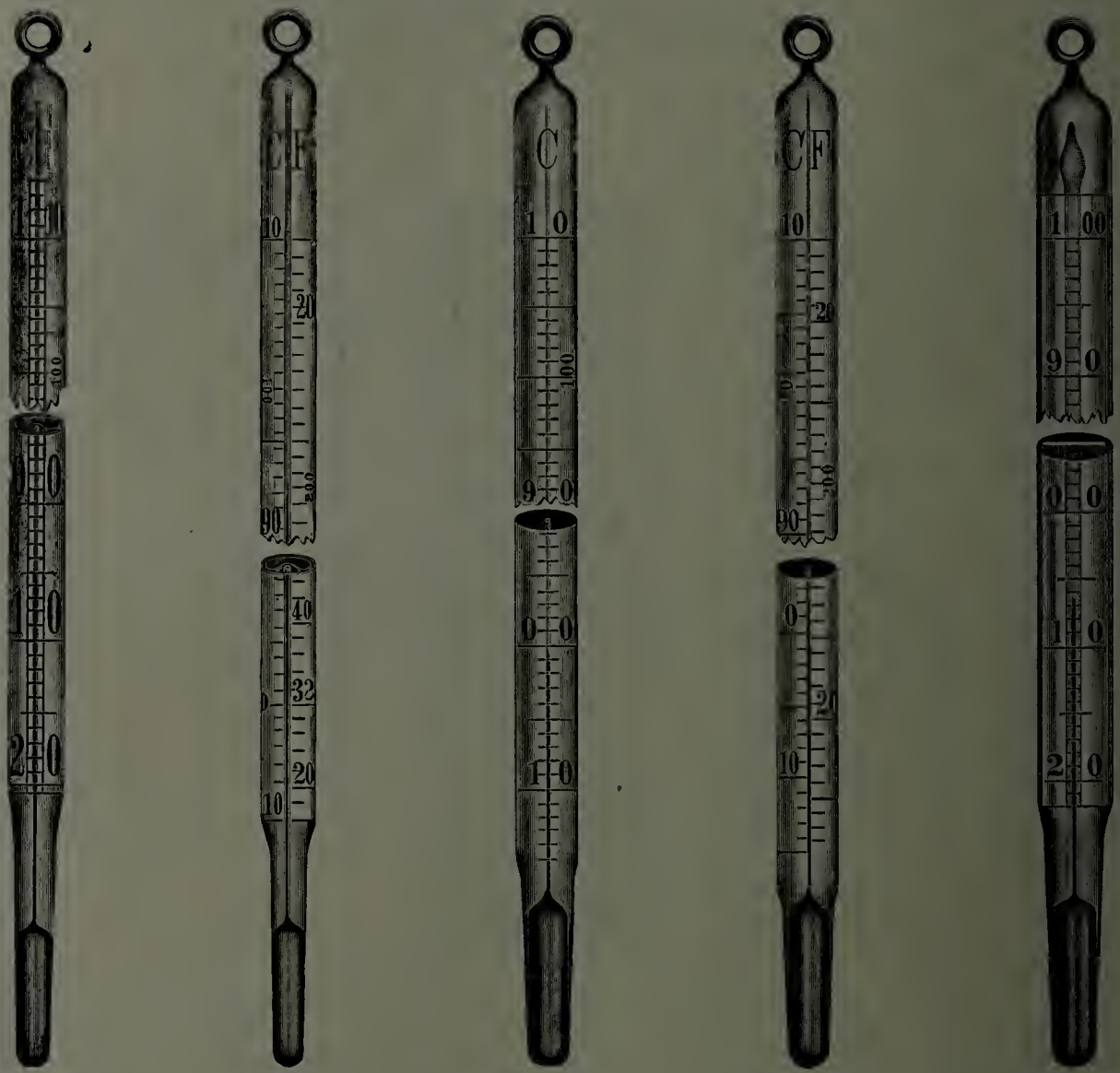
63–12 HOUSEHOLD THERMOMETER, 10 inches long, silvered scale on hardwood back, reading from –30 degrees to 120 degrees Fahrenheit . . . . . **.95**

63–15 COMPARATIVE THERMOMETER, three Scale, Fahrenheit, Centigrade, and Reaumur. This is a thermometer, 10 inches long, designed to give the student an instrument which will give a reading in all three scales, thus showing direct comparisons. Made of boxwood, piano rubbed finish, all graduations and letterings distinct. Bulb protected by metal covering . . . . . **.80**

63–18 METALLIC THERMOMETER, DEMONSTRATION FORM, with glass back, entire mechanism visible. Diameter 6 inches. This thermometer will be of great pedagogic value in that it shows at a glance the method of multiplying the movement made by two metals soldered together. Range from 50 degrees below to 150 degrees Fahrenheit **$4.40**

63–20 GROUND GLASS UNGRADUATED THERMOMETER, 13 inches long, half its circumference etched through its entire length. In calling attention to this thermometer, we request that it be not confused with those on the market. With this thermometer, a student can find and mark in pencil on the etched portion both its zero and boiling points. When these are obtained, it will require very little skill on his part to make a complete thermometer. The etched portion obviates the disagreeable features of rubber bands and other indicators. Each 50 cents . . . . Per Doz. **5.75**

CHEMICAL THERMOMETERS



No. 63–30 No. 63–37 No. 63–50 No. 63–60 No. 63–70

63–25 **CHEMICAL THERMOMETER,** paper scale, 8 inches long, with scale reading from −10 to 100° Centigrade, enclosed in case $0.75

63–26 ——, paper scale, 8 inches long, with scale reading from 0 to 220° Fahrenheit, enclosed in case 55

63–30 **CHEMICAL THERMOMETER,** paper scale, 13 inches long, with scale reading from −10 to 110° Centigrade, enclosed in case 1.00

63–32 ——, paper scale, 13 inches long, with scale reading from −10 to 210° Centigrade, enclosed in case 1.00

63–35 ——, paper scale, 13 inches long, with scale reading from 15 to 220° Fahrenheit, enclosed in case 1.00

63–36 ——, paper scale, 13 inches long, with scale reading from 15 to 400° Fahrenheit, enclosed in case 1.25

63–37 **CHEMICAL THERMOMETER,** paper scale, 13 inches long, with **double scale** reading from −10 to 110° C. and with equivalent Fahrenheit scale to 220°.
Enclosed in case 1.15

63–38 ——, paper scale, 13 inches long, with **double scale** reading from −10 to 210° C. and with equivalent Fahrenheit scale to 400°.
Enclosed in case 1.35

63–50 **CHEMICAL THERMOMETER,** stem scale, white enameled back, 13 inches long, graduated from −10 to 110° C.
Enclosed in wooden case 1.15

63–52 ——, stem scale, white enameled back, 13 inches long, graduated from −10 to 210° C.
Enclosed in wooden case 1.25

63–55 **CHEMICAL THERMOMETER,** stem scale, white enameled back, 14 inches long, graduated from −10 to 360° Centigrade, enclosed in wooden case $1.50

63–57 ——, stem scale, white enameled back, 14 inches long, graduated from 15 to 600° Fahrenheit, enclosed in wooden case 1.50

63–60 ——, stem scale, white enameled back, 14 inches long, **double graduations,** from −10 to 110° Centigrade and with equivalent Fahrenheit scale to 220°, enclosed in wooden case 1.50

63–62 ——, stem scale, white enameled back, 14 inches long, **double graduations,** from −10 to 210° Centigrade and with equivalent Fahrenheit scale to 400°, enclosed in wooden case 1.75

63–64 ——, stem scale, white enameled back, 14 inches long, **double graduations,** from −10 to 360° Centigrade, with equivalent Fahrenheit scale to 600°, enclosed in wooden case 2.00

63–70 **CHEMICAL THERMOMETER,** enclosed milk glass scale, 13 inches long, graduated from −10 to 110° Centigrade, enclosed in wooden case 1.25

63–72 ——, enclosed milk glass scale, 13 inches long, graduated from −10 to 250° Centigrade, enclosed in wooden case 1.50

STANDARD THERMOMETERS

63–80 **STANDARD CHEMICAL THERMOMETER,** scale engraved on the stem, white enameled back, 16 inches long, graduated from 0 to 100° Centigrade by 1/5 degrees, enclosed in wooden case $3.00

63–85 **STANDARD CHEMICAL THERMOMETER,** scale engraved on the stem, white enameled back, 25 inches long, graduated from 0 to 100° Centigrade by 1/10 degrees, enclosed in wooden case . . 4.50

No. 63–145

63-125 **STANDARD THERMOMETERS,** Centigrade scale, engraved stem, each with zero and boiling points. Set of four as follows, enclosed in fine leather case:

0 to 100° × 1/10 — 100 to 200° × 1/10
200 to 300° × 1/5 — 300 to 400° × ½

Duty Free $19.80

63-135 **STANDARD THERMOMETERS,** Centigrade scale, after Allihn, enclosed pearl glass scale, set of three about 12 × ¼ inch, each with zero and boiling points, divided to ½ degrees. Set as follows:

−15 to 100° — 100 to 200° — 200 to 300°

In fine leather case, Duty Free 13.50

63-145 **STANDARD THERMOMETERS,** Centigrade scale, after Anschuetz, enclosed pearl glass scale, about 4 to 6 inches long by ¼ inch diameter. Set of seven by 1/5 degrees as follows:

10 to 60° — 40 to 110° — 90 to 160° — 150 to 220° — 200 to 270° — 250 to 310° — 300 to 360°

In fine leather case, Duty Free 14.75

MISCELLANEOUS STANDARD THERMOMETERS

63–155 **BECKMANN'S NORMAL DIFFERENTIAL THERMOMETERS,** for boiling or freezing point methods in molecular weight determinations, etc.

	a	b	c	d	e
Range, Degrees C.	1	5 to 6	10 to 12	25 to 30	50 to 60
Divided, degree	1/500	1/100	1/50	1/20	1/10
Each, Duty Free	$9.80	6.50	6.50	6.25	6.25

63–165 **CALORIMETRIC THERMOMETER,** about 20 inches long, scale engraved on pearl glass, from 15 to 25 degrees Centigrade by 1/100 degree Duty Free **$7.25**

63–170 **HYPSOMETER THERMOMETER,** scale etched on stem, length about 14 inches, 90 to 102° Centigrade by 1/10 degree, with zero and boiling points. Duty Free **6.00**

63–172 ——, same as above, 95 to 102° C. by 1/20 degree. . . . . Duty Free **7.75**

63–180 **HIGH TEMPERATURE THERMOMETERS,** Centigrade scale, about 12 to 14 inches long, in the following ranges by single degrees:
0 to 130° 100 to 300° 200 to 540°
Per set of three, in fine leather case. Duty Free **19.50**

63–182 ——, same as above, but with certificate of accuracy from Physik-Technische Reichsanstalt in Charlottenburg . . . . . Duty Free **27.50**

63–190 **LOW TEMPERATURE THERMOMETER,** stem graduation by single degrees, from −50 to 50° Centigrade; without certificate . . . Duty Free **6.25**

63–191 ——, same as above, with certificate from Physik-Technische Reichsanstalt Duty Free **9.75**

63–193 **LOW TEMPERATURE THERMOMETER,** stem graduation by single degrees, from −100 to 10° Centigrade; without certificate . . . Duty Free **7.25**

63–194 ——, same as above, with certificate from Physik-Technische Reichsanstalt Duty Free **12.50**

63–196 **LOW TEMPERATURE THERMOMETER,** stem graduations by single degrees, from −200 to 10° Centigrade, for measuring the temperature of liquid air; without certificate . . . . . Duty Free **13.25**

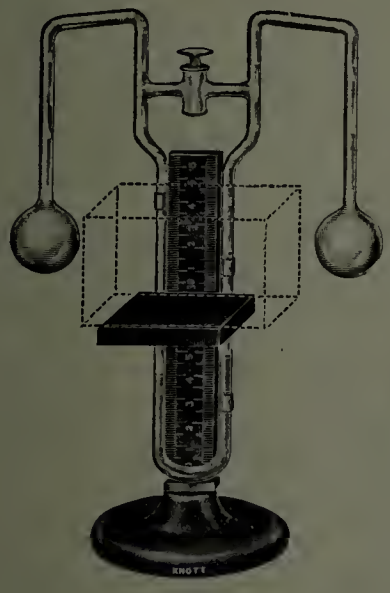
63–197 ——, same as above, with certificate from Physik-Technische Reichsanstalt Duty Free **16.50**

No. 63–155b

No. 63–155a

SPECIAL THERMOMETRIC INSTRUMENTS

DIFFERENTIAL THERMOSCOPES



No. 64–15

No. 64–20

64–15 UNIVERSAL AIR AND LIQUID DIFFERENTIAL THERMOSCOPE. This design, a modification according to our specifications, may be used equally well for indicating the temperature of liquids, as in comparing temperature of two neighboring places. Thus, as may be noted from our illustration, the thermoscope bulbs are bent downward yet opposite the small table which is designed especially for holding the source of radiant energy. The illustration shows our No. **61–100** Leslie's Cube in position, and comparison of liquids may be demonstrated by use of two vessels containing the liquid, the bulbs dipping into the vessels. The bent U-tube contains the colored liquid, and in a tube which connects the two limbs is a stop-cock by which the liquid in each limb is easily brought to the same level. This glass part is mounted in a frame with a scale, the whole mounted on a neat base.
Without the illustrated Leslie's Cube **$7.50**

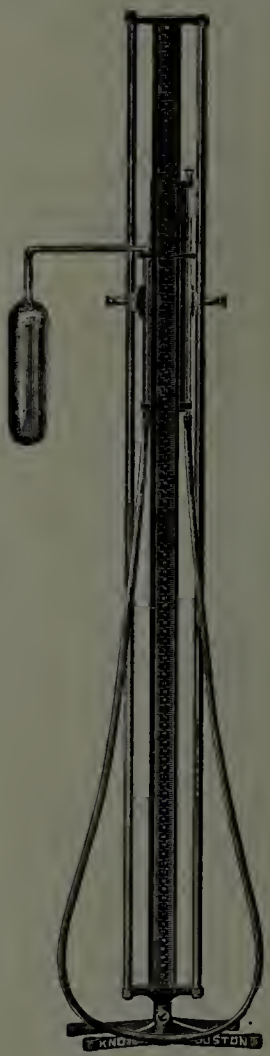
64–20 DIFFERENTIAL THERMOSCOPE, for indicating a difference of temperature between two bulbs. The apparatus consists of two bulbs connected by a U-tube, from which air has been expelled by boiling before sealing, the liquid contained therein as an indicator. This tube with attached bulb is mounted with scale on an upright support **1.95**

No.64–30

64–30 AIR THERMOMETER, after Rendtorff, for showing expansion of air by heat.
This thermometer consists of a bulb into which is sealed a capillary tube, the end of which tube extends nearly to the bottom of the bulb. Through the bulb and sealed into the opposite walls is a wire of high resistivity. Terminals are left outside the bulb for connection to battery. The whole apparatus is freed from air, before sealing, by boiling the colored liquid contained therein **2.25**

64–35 AIR THERMOMETER, for illustrating gas expansion, of glass, with two-inch bulb . . . **.17**

AIR THERMOMETERS



No. 64–55

No. 64–65

No. 64–70

64–55 **CONSTANT VOLUME AIR THERMOMETER,** for determining the coefficient of expansion of air, or of a gas.

This apparatus consists of a rectangular frame with the scale mounted on one of our H-bases. The air thermometer, fastened by a protective strip of wood, is adjustably clamped to one rod and the open leveling tube similarly mounted and clamped to the other rod. The open lower ends of each are connected by the finest quality of flexible rubber tubing.

This instrument is substantially constructed throughout and handsomely finished in nickel-plate and japan. It has been designed that laboratories may have at a reasonable cost an instrument capable of accurate determinations. We have no hesitancy in recommending it as capable of results attained by instruments of double the cost.

Complete as illustrated $8.50

64–57 **AIR THERMOMETER BULB,** for attachment to above stand to replace breakage 75

64–59 **BOYLE'S LAW TUBE,** for use on above stand in determining Boyle's Law. This tube may be mounted in place of the air thermometer pictured in above illustration. For apparatus complete see No. **41–110** 1.25

64–65 **AIR THERMOMETER,** after Millikan, Gale and Bishop, Exp. 14, for determining the coefficient of expansion of air.

This is an elementary air thermometer, capable of a fair degree of accuracy. It consists of an air thermometer tube, leveling tube, and scale mounted to a backing which may be adjusted along the rod of the tripod stand by means of a clamp attached to the backing. The lower open ends of the tubes are connected by our finest quality flexible antimony rubber tubing. The apparatus is durably finished, the metal parts in bright nickel and japan.

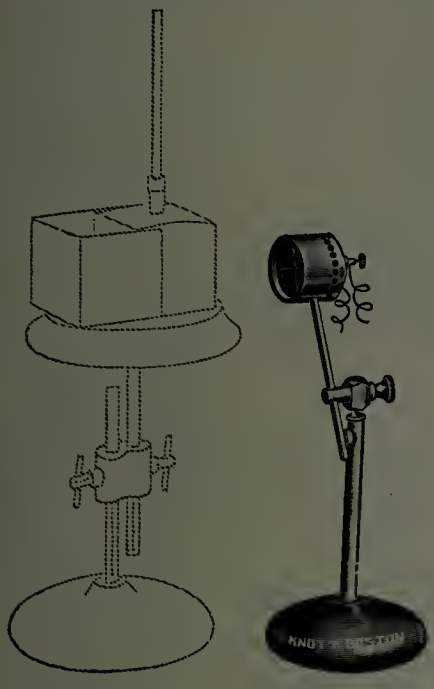
Complete as illustrated 3.30

64–66 ——, without support 1.65

64–67 **AIR THERMOMETER BULB,** as used in above apparatus . . . . . Each .45

64–70 **CONSTANT VOLUME AIR THERMOMETER,** highest quality constructed by one of the most prominent European manufacturers and extensively used as a precision instrument . . Duty free . . .

AN IMPROVED MINERALITE THERMOPILE



No. 64–100

We offer in this series of Thermopiles, instruments of two sizes which cover all ranges in both amperage and voltage, of the Bismuth Antimony type, from the single pair to 120 pair.

A study of the table below will show the relative strength of our sizes A and B as compared with the Bismuth Antimony Pile of twenty pair, which is usually taken as the standard in Thermo-electric Measurement.

The advantages of the Improved Mineralite Pile are **much greater sensibility, greater mechanical strength, and greater durability.**

In preparing the data given in Table I below, we have used a unit area of metallic surface kept at 100° Centigrade and distant from the Pile 10 centimeters. Deflections in each case are read by a galvanometer of standard D'Arsonval type. In Table II, the source of heat is the direct rays of the sun, the experiment being taken on a typical Boston winter's day.

TABLE I

UNIT AREA METALLIC SURFACE AT 100° CENTIGRADE. TEN CENTIMETERS DISTANT FROM FACE OF PILE

INSTRUMENT	TIME		
	30 Seconds	1 Minute	2 Minutes
20 pair Bismuth Antimony	9 Divisions	11 Divisions	10 Divisions
Mineralite A	30 Divisions	34 Divisions	36 Divisions
Mineralite B	45 Divisions	52 Divisions	55 Divisions

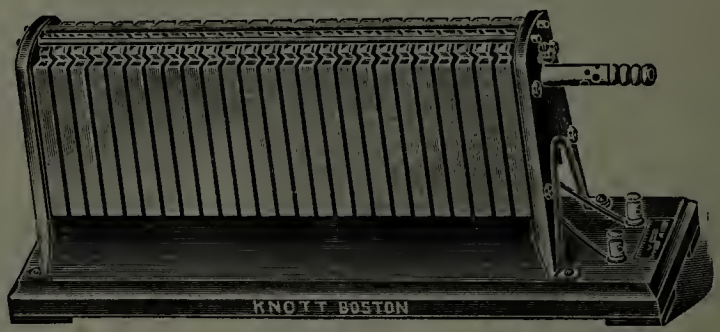
TABLE II

DIRECT SUNLIGHT AS SOURCE OF HEAT

INSTRUMENT	TIME
	1 Minute
20 pair Bismuth Antimony	17 Divisions
Mineralite A	83 Divisions
Mineralite B	167 Divisions

64–100 IMPROVED MINERALITE THERMOPILE A with stand **$11.75**
64–110 IMPROVED MINERALITE THERMOPILE B with stand **14.50**
OTHER RADIOMETERS. Section **61.**

THERMO-ELECTRIC BATTERIES



No. 64–127

Thermo-Electricity has been a matter of study for a number of years, but the principal use of a thermo-electric couple or a thermopile has been that of a sensitive radiometer. The new thermo-electric instrument above illustrated is designed for practical use, — that of a thermo-electric battery. These forms are of simplified construction, low-priced and with highly efficient output. With the larger sizes, small machinery may be operated, incandescent lamps lighted, storage batteries charged, etc. For experiments in electrolysis, they are, perhaps, unexcelled. From the fact that they may be operated instantly and need no attention, their popularity in this country and abroad has been continually increasing. Each battery is supplied complete with burner.

64–125 **THERMO-ELECTRIC BATTERY,** 26 elements, E. M. F. 1.8 to 2.2 volts; current strength on short circuit 3 to 4 amperes.
Complete with Gas Burner . . . . . Duty Free . . .

64–125a ——, same as above, but with Alcohol Burner . . . . . Duty Free . . .

64–126 **THERMO-ELECTRIC BATTERY,** similar to above, but larger, 38 elements, E. M. F. 2.8 to 3.2 volts; current strength on short circuit 3 to 4 amperes.
Complete with Gas Burner . . . . . Duty Free . . .

64–126a ——, same as above, but with Alcohol Burner . . . . . Duty Free . . .

64–127 **THERMO-ELECTRIC BATTERY,** similar to above, but larger, 50 elements, E. M. F. about 4.2 volts; current strength about 4 amperes.
Complete with Gas Burner . . . . . Duty Free . . .

64–127a ——, same as above, but with Alcohol Burner . . . . . Duty Free . . .

64–128 **THERMO-ELECTRIC BATTERY,** extra large, 100 elements, E. M. F. 4 to 4.5 volts; current strength on short circuit 4 to 5 amperes.
This battery is especially adapted for charging a 7 to 10 ampere storage cell.
Complete with Gas Burner . . . . . Duty Free . . .

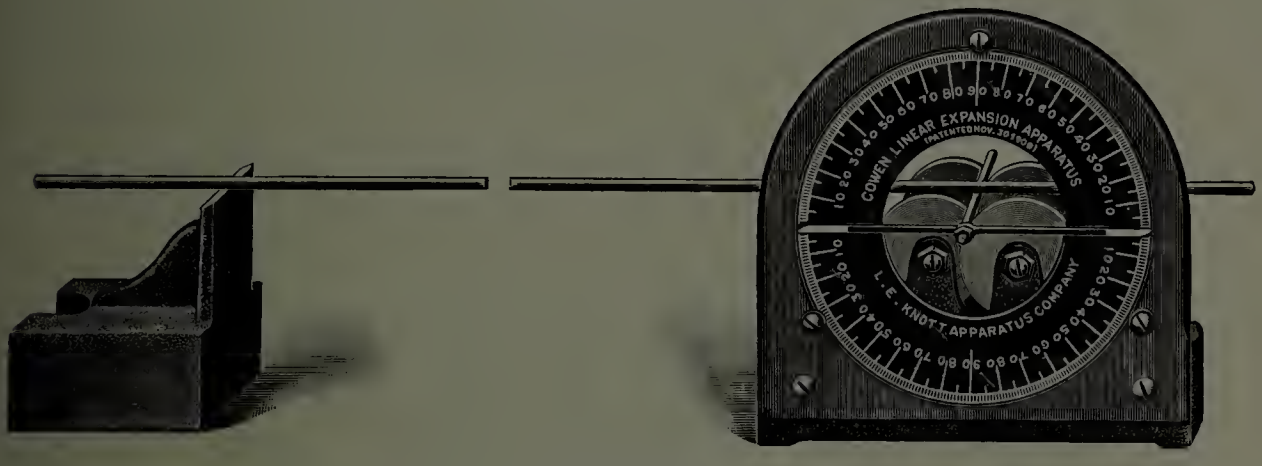
64–128a ——, same as above, but with Alcohol Burner . . . . . Duty Free . . .

No. 64–160

64–160 **PORTABLE INDICATING ELECTRIC PYROMETER** for indicating temperatures not exceeding 2000 degrees Fahrenheit (1100 degrees Centigrade).
This instrument is rugged in structure, durably and handsomely finished. It is furnished with a base-metal Thermo-couple and indicates the temperature within a minute or two after the Thermo-couple has been inserted in the high heat.
With Thermo-couple and 15 feet of Flexible Cable **$60.00**

EXPANSION OF MATTER

LINEAR EXPANSION APPARATUS



No. 65–10

65–10 **COWEN'S LINEAR EXPANSION APPARATUS,** for the rapid measurement of linear expansion of solids.

The apparatus consists of a multiplying device on which the solid in the form of a tube rests. Any movement of the tube lengthwise is greatly multiplied and accurately indicated on a graduated dial. All parts are accurately fitted and handsomely finished. The apparatus occupies a small space, yet from its mechanism presents a highly scientific appearance.

Results of extensive use have brought out the following features, — **SIMPLICITY;** no complicated mechanism for clamping the rod and measuring same, the movement lengthwise merely being multiplied by our patented device, the mechanism of which can readily be understood by even the most unscientific mind: **ADAPTABILITY;** this instrument, taking a tube of any length from 20 centimeters up and any diameter desired: **ACCURACY;** in the shortest time possible and with a minimum of trouble, an accuracy in excess of the ordinary form of linear expansion, is possible with this, our patented design, inasmuch as reasonable errors of observation cause only slight errors in final determinations.

Apparatus complete, including one brass tube $3.00

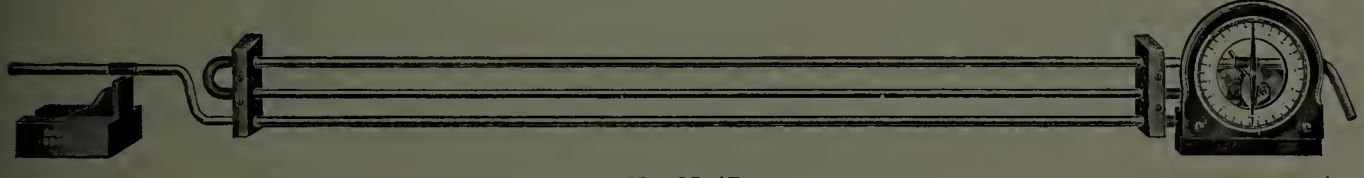
65–11 **STEEL TUBE,** for use with above 45

65–12 **ALUMINUM TUBE,** for use with above 45

65–13 **BRASS TUBE,** as used in above 40

65–14 **GLASS TUBE,** for use with above 20

65–16 **GLASS RESERVOIR AND STIRRER** after Turner and Hersey, Exp. H023 25



No. 65–17

65–17 **COWEN COMPENSATION APPARATUS,** as designed by George A. Cowen of the West Roxbury High School, to use in connection with apparatus No. **65–10** in demonstrating the effect of multiple bars of different coefficients of linear expansion as used in the Compound Pendulum.

The apparatus is simple in form, as shown in the cut, the various expanding bars being held together with two brass clamps on the same principle as the multiple bars are held in the Compensated Pendulum.

A most interesting phenomenon is observed when the steam enters from the steam boiler. The tube which is reached first by the steam, expands, causing the pointer to make rapid movement toward the left. When the steam reaches the second bar of the system, this being the bar of greatest coefficient of expansion, the pointer moves to the right to and well beyond the starting point. When the steam reaches the third bar of the system, it will again move to the left, reaching the zero point from which it started and there stop, showing successively the relative expansion of the tubes in the order in which the steam strikes them.

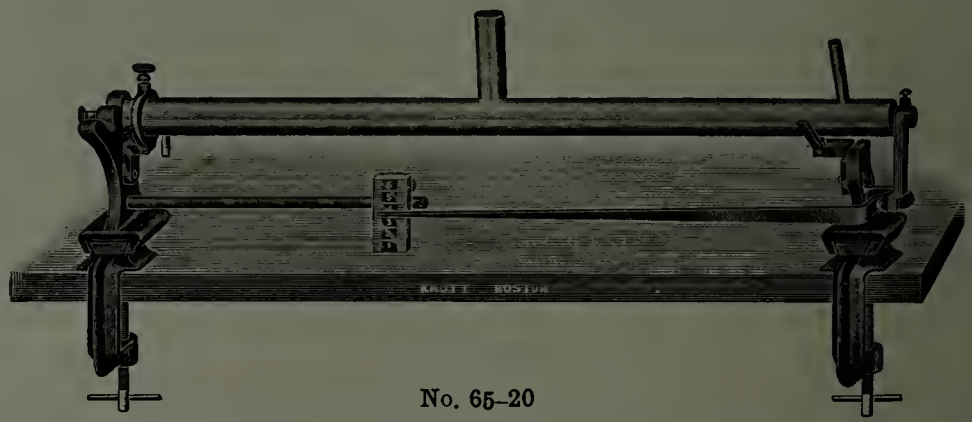
We recommend that this piece of apparatus be placed in the hands of the individual student where possible, although the effect is sufficiently striking to serve well as a lecture table demonstration.

Complete as illustrated $5.00

65–18 **COWEN COMPENSATING ATTACHMENT,** for use with Cowen's Linear Expansion Apparatus No. **65–10** 2.40

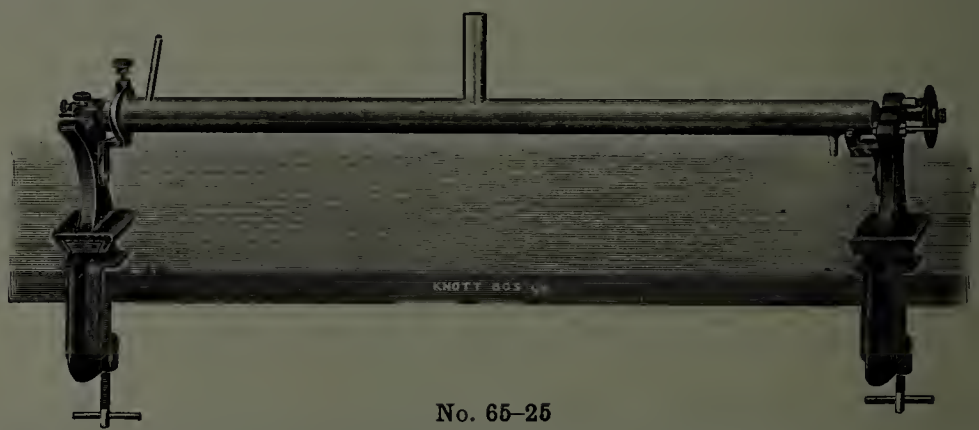
T-BEAM SERIES LINEAR EXPANSION APPARATUS (LEVER AND MICROMETER FORMS)

The advantages of this type of apparatus will be readily seen from the cut, — substantial construction, the ends clamped securely to the table avoiding all errors due to the supports not being rigid, the distance between the supports easily varied to meet varying conditions. The metal brace between the two uprights formerly used has been eliminated, doing away with the unavoidable error arising from the expansion of this brace by the heat radiated from the steam jacket. Please note that the supporting ends of our instruments are attached by the well-known Interlocking T-beam Attachments to the standard Basic Clamps "A," strong and rigid clamps which hold the apparatus securely to the table top. The uniformly accurate results which these instruments give are due to the fact that all possible sources of error have been carefully worked out and eliminated.



No. 65–20

65–20 **T-BEAM SERIES LEVER EXPANSION APPARATUS,** complete as illustrated without Basic Clamps **$3.25**
5–1000 **T-BEAM BASIC CLAMP "A,"** two of which are required for above apparatus . . . . . Each **.94**
65–22 **LEVER FORM LINEAR EXPANSION APPARATUS,** similar to No. **65–20**, but designed to rest on the table. A nickel-plated metal brace connects the two uprights. Complete with one expansion rod **2.65**



No. 65–25

65–25 **T-BEAM SERIES MICROMETER SCREW EXPANSION APPARATUS,** complete as illustrated without Basic Clamps **$3.85**
5–1000 **HARCOURT UNIVERSAL T-BEAM BASIC CLAMP "A,"** two of which are required for above Each **.94**
65–27 **MICROMETER SCREW LINEAR EXPANSION APPARATUS,** similar to No. **65–25**, but designed to rest on the table. A nickel-plated metal brace connects the two uprights Complete with one expansion rod **4.50**

THE IMPROVED SPINE-SUPPORTED LINEAR EXPANSION APPARATUS

In this series of Linear Expansion Apparatus we wish to call particular attention to the improved method of supporting the tube, it being held lengthwise on the top edge of a substantial oak spine, but not in actual contact with the wood. The design is such that the drip from the falling water or the radiated heat from the tube introduces no error, a very important feature in all designs of apparatus for determining the Coefficient of Linear Expansion.

The apparatus is offered both in the Lever and Micrometer form.

No. 65–30
Patented Sept. 7, 1906

65–30 **SPINE-SUPPORTED LEVER FORM EXPANSION APPARATUS,** complete, including Brass Rod **$4.40**

No. 65–40

65–40 **SPINE SUPPORTED MICROMETER SCREW FORM LINEAR EXPANSION APPARATUS,** for determining the coefficient of linear expansion of a rod.

This form of expansion coefficient apparatus substitutes a micrometer screw in place of lever for reading the expansion. A lever at the other end of the rod facilitates in the zero readings, indicating positive contacts of the end of the micrometer screw on the rod, thus avoiding the inconveniences of electrical connections and overcoming absolutely the errors to which the electrical method is liable.

Mounted on handsomely finished hardwood support $4.50

65–45 **ALUMINUM ROD,** for use with Nos. **65–20** to **65–40** 45

65–46 **IRON ROD,** for use with Nos. **65–20** to **65–40** 40

65–70 **BRASS TUBE AND POINTER** after Millikan, Gale and Bishop, Exp. 15 65

No. 65–75

No. 65–110

No. 55–80

No. 65–80

65–75 **COMPOUND BAR,** for showing unequal expansion of metal.

This apparatus consists of two welded pieces of metal, iron and brass, which when heated will show their unequal expansion qualities by bending in the form of an arc, the inner part of which will be the metal of lesser expansibility.

Complete as illustrated, with handle for comfortable heating $0.55

65–80 **COMPOUND BAR WITH INDICATOR,** for showing the unequal expansion of two metals.

This is an ingenious device for registering on a dial the expansion of the metal of the greater expansibility 4.00

65–110 **GRAVESEND BALL AND RING,** for illustrating expansion of metal upon application of heat and contraction upon withdrawal.

The apparatus consists of a polished metal ball and a ring through which the ball at ordinary temperature will just pass, each of which is attached to a metal rod with handle end.

At ordinary temperature, the ball will just pass through the ring, but when heated, it cannot be forced through. Cooled below ordinary temperature, it will fit loosely 98

17–60 **COMPENSATED PENDULUM,** illustrating method of time compensation by application of unequal expansion of rods 12.35

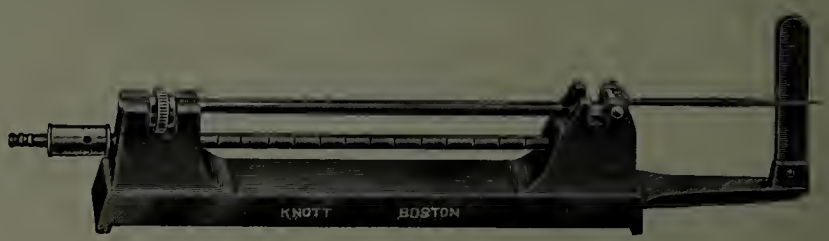
55–80 **TREVELYAN'S ROCKER,** for illustrating that musical vibrations are maintained by communication of heat.

The apparatus consists of a brass rod with a V groove milled lengthwise. To this rod is fastened a metal handle with ball end. When this bar is heated at some point below the melting point of lead and placed so that the edges of the V groove rest on the lead casting as indicated, the bar begins to emit a harsh note. This note may be made to rise in pitch by slightly pressing on the bar.

Trevelyan's Rocker with Lead Rest 2.00

PACKARD'S

BREAKING BY EXPANSION AND CONTRACTION APPARATUS No. 65–130



No. 65–130

No. 65–130 (Fig. 2)

No. 65–130 (Fig. 3)

This piece of apparatus has been designed to demonstrate most effectively the power exerted by an expanding or contracting metal bar. The expansion is obtained by a burner in tube form indicated in the illustration. The power exerted by the expanding or contracting rod is presented most strikingly by the breaking of a steel bar placed in the slot in the end and at right angles resting against knife edge supports.

It will thus be seen that whether the rod be heated by the tube, or allowed to contract in the process of cooling, the bar will be broken and at the instant of breaking the lever will be thrown violently, the results being therefore striking by the breaking of the bar, the sudden rising of the pointer and the noise, leaving no doubt in the student's mind that great force has been exerted.

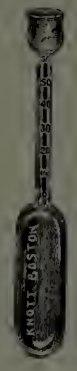
In addition to the above features the instrument makes a most satisfactory lecture table piece for teaching briefly but quickly the principle of expanding by heat.

The substantial construction, careful workmanship and correct design make this a most satisfactory lecture table demonstration piece. Twelve steel bars for breaking supplied with each instrument.

Please note that the above instrument serves to teach the force exerted by an expanding rod, force exerted by a contracting rod and the relative amount of expanding and contracting by heat.

Complete as illustrated $8.75

No. 65–150



No. 62–240

65–150 **HOPE'S MAXIMUM DENSITY OF WATER APPARATUS** for illustrating the point of Maximum Density of Water, also for explaining reason why the surface of a pond may be covered with ice while underneath is water.

The apparatus consists of a cylindrical jar in the sides of which, near top and bottom, are drilled holes to contain sensitive thermometers. Around this jar about midway between these holes is sealed a spun copper ice container.

In use, the jar is filled with water sufficient to immerse the upper thermometer bulb. A freezing mixture is placed in the copper ice container. As the water in the jar cools, the density is increased, the more dense portion sinking to the bottom, where its temperature will be registered by the lower thermometer. It will be noted that the reading of this thermometer will be lower than that of the upper until 4° Centigrade is reached, at which point the reading will remain stationary, whereas the upper will continue to descend until 0° Centigrade is reached.

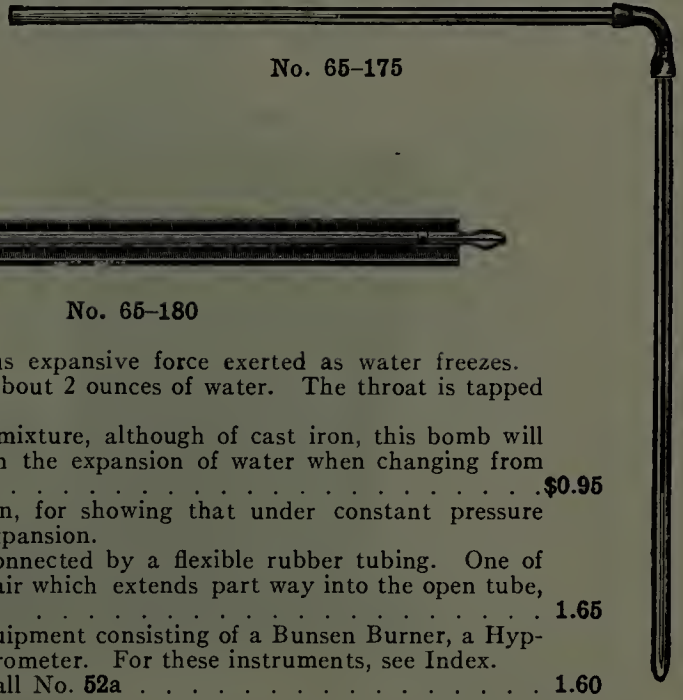
Complete as illustrated, with rubber stoppers for thermometers but without thermometers . . . **$5.00**

THERMOMETERS. Section **63**.

62–240 **DESPRETZ WATER THERMOMETER** for indicating cubical expansion of liquid or for determining the maximum density of water. (See Section **62**.) **1.10**

No. 65–170

No. 65–180



No. 65–175

65–170 **FREEZING BOMB,** illustrating the tremendous expansive force exerted as water freezes.

Consists of a cast-iron sphere cored to contain about 2 ounces of water. The throat is tapped to receive a screw plug.

When filled with water and placed in freezing mixture, although of cast iron, this bomb will burst from the tremendous force exerted from the expansion of water when changing from the liquid to the solid state **$0.95**

65–175 **CHARLES LAW TUBE,** after Hall and Bergen, for showing that under constant pressure different gases possess the same coefficient of expansion.

This consists of two tubes of capillary bore, connected by a flexible rubber tubing. One of these tubes has a closed end and contains dry air which extends part way into the open tube, in which is an indicating globule of mercury **1.65**

NOTE. The use of this tube presupposes an equipment consisting of a Bunsen Burner, a Hypsometer, an Ice Tray, a Meter Rod, and a Barometer. For these instruments, see Index.

65–177 **LEVELING TABLE** for use with above after Hall No. **52a** **1.60**

65–180 **WATERMAN'S CHARLES LAW TUBE** for similar use as above, requiring practically the same accessories.

The apparatus consists of tube of capillary bore, one end of which is sealed and contains dry air stoppered by a globule of mercury. This tube is mounted on a graduated backing for direct measurement of air expansion **1.75**

65–191 **VOLUME COEFFICIENT TUBE,** after Millikan, Gale and Bishop (Experiment **14a**) . . . . . **.10**

MEASUREMENT OF THE QUANTITY OF HEAT

CALORIMETERS

66–10 PARR'S STANDARD CALORIMETER for determining the calories of heat developed by the combustion of bituminous and anthracite coals, lignites, coke, etc.

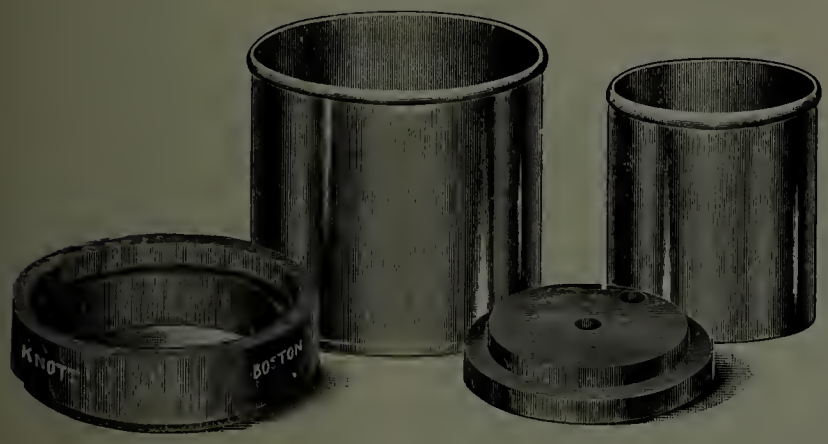
No. 66–10

The apparatus consists of a cartridge in which is placed the combustible material in the form of a powder and mixed with a chemical compound. This cartridge is placed in a measured quantity of water in an insulated calorimeter can. This calorimeter can is contained within two insulating vessels with air spaces between. The pulley noted in the illustration operates the cartridge and is provided with small vanes for causing a constant uniform stirring of the water. This pulley may be driven by any convenient means at hand. The illustrations show it in use driven by Electrical Motor. In use, the coal or combustible substance is ground to pass through a 100 mesh sieve and a weighed quantity is put into the cartridge together with a chemical compound. A measured quantity of water is then placed in the insulated calorimeter can. The stirrer is then set in motion, operated either by water or electric power. After a constant temperature has been obtained, ignition is effected by means of a short piece of hot wire dropped through the stem of the cartridge. Extraction of the heat is completed in from four to five minutes. The maximum reading is taken and the rise of temperature multiplied by a simple factor gives the heat in B. T. U. per pound of coal.

The complete calorimeter outfit includes a fine thermometer graduated to $\frac{1}{20}°$ F. with certificate of accuracy, a two-liter measuring flask, chemical receptacle, measuring cup, 5-inch 100 mesh brass sieve with bottom, chemicals sufficient for 10 determinations, pincers, ignition wire, reading lens, and camel's hair brush **$77.00**

No. 66–11

66–11 PARR'S STANDARD CALORIMETER, same as above, but equipped for electric ignition **$82.50**
66–12 WATER MOTOR AND SUPPORT . . . . . Extra **5.50**
66–13 ELECTRIC MOTOR, Lamp series, as illustrated above . . . . . Extra **13.20**
66–14 SUPPORT FOR ELECTRIC MOTOR, as illustrated above . . . . . Extra **2.75**



No. 66–35

No. 66–45

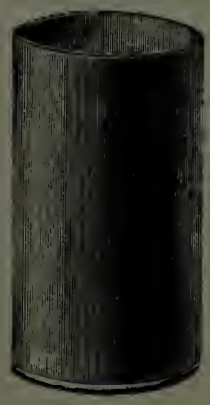
No. 66–50

66–35 CINCINNATI DOUBLE WALL CALORIMETER. Consists of two nickel-plated brass vessels, the smaller resting on a supporting ring within the larger. A cover with holes for thermometer and stirrer is supplied with the outfit. Complete **$1.40**

66–45 DOUBLE WALL CALORIMETER, similar to above but larger, and spun from sheet copper. Heavily nickel-plated inside and out. A cover with holes for thermometer and stirrer is supplied with the outfit. Complete **2.95**

66–50 CULLER'S CONDENSER ATTACHMENT for use with above or other calorimeters to determine Latent Heat of Steam. (See Culler's "Laboratory Manual of Physics," Experiment **XXIII**) . . . **.95**

No. 61–205



No. 66–65

No. 66–75

61–205 DOUBLE WALL CALORIMETER, of glass. This is a double-walled vessel with outlet for evacuating chamber between walls. It will be found invaluable in calorimetric work **$3.25**

66–65 CALORIMETER for general laboratory usage in secondary school work in calorimetry. This is the popular nickel-plated brass calorimeter used so frequently in determinations of specific heat, latent heat of melting ice, latent heat of evaporization, and quite frequently for dew point tests. Capacity about 1 liter . . . . . **.50**

66–70 STIRRER for use with above calorimeters . . . . . **.20**

66–75 BUNSEN'S ICE CALORIMETER, standard form, consisting of a bulb with sealed-in test tube and bent mercury tube **1.25**

ELECTRIC CALORIMETERS

No. 66–100

66–100 THE IMPROVED ELECTRIC CALORIMETER, designed after Stewart & Gee's "Practical Physics," Lesson 47. This instrument was designed for the purpose of applying Joule's Law in the determination of the constant of a Galvanometer, consequently the best possible results must be obtained. The calorimeter proper is of the form shown under No. **66–105.** This is placed in the secondary chamber as shown in the illustration, the space between the outer chamber and the polished surface of the outer wall of the calorimeter being filled with an insulating compound composed largely of magnesium carbonate.

Complete as illustrated **$9.90**

No. 66–105

66–105 DOUBLE WALL ELECTRIC CALORIMETER, after Millikan & Mills' "Electricity, Sound and Light," (Experiment 4), for testing the calibration of a voltmeter by an absolute determination of potential difference. This calorimeter consists of two heavy copper vessels, the inner of about 350 cubic centimeters capacity, insulated from and supported on the outer by a fiber ring. A coil of fine platinum wire is wound on an insulating strip which is connected to two brass rods. These rods extend through the cover and end in binding post terminals. Two holes are provided in this cover, one for a thermometer, the second for a handle of a stirrer, which has heat insulating end.

Complete as illustrated **$6.85**

No. 66–110

66–108 HEATING COIL ATTACHMENT, mounted on fiber cover. This attachment is intended for use with No. **66–45** to make up Electric Calorimeter above. Teachers, therefore, who already have No. **66–45** Double Wall Calorimeter need order this attachment only, to obtain Electric Calorimeter No. **66–105** **$3.90**

66–110 STUDENTS' ELECTRIC CALORIMETER for determining the number of calories of heat developed in a wire; also for the study of Joule's Law.

The apparatus consists of a glass jar, in the neck of which is placed an insulating cover bearing two rods, each terminating in a binding post connected to the ends of a coil of resistance wire. In the center of this cover is a hole for the thermometer.

Complete as illustrated, without thermometer **2.10**

JUNKER'S CALORIMETER

66–125 SIMPLIFIED JUNKER'S CALORIMETER for determining the calorific power of combustible gases. In the design above illustrated the heated gases enter the inner chamber of a triple-walled vessel. Within this chamber these gases come in contact with a coil of copper tubing through which a current of water continually flows. The temperature of this water is noted at entering as well as upon issuing from the coil, by the means of the thermometers noted in the illustration. In order to determine the B. T. U., the quantity of gas consumed and the quantity of water passed through the apparatus must be determined in addition to the difference in temperature. In determining the quantity of gas consumed we advise our No. **66–130** Thorpe Gauge.

This instrument is substantial in structure, the fundamental part consisting of a casting to which are mounted the two thermometer tubes. On this casting is mounted a double-walled metal chamber surrounded by an insulating compound. The ends of the copper circulating coil supported from above to the inner metal vessel are connected through the casting to the thermometer tubes. The instrument may be mounted on our special stand as illustrated or may be attached to any tripod stand by means of a clamp.

Simplified Junker's Calorimeter only **$14.40**

No. 66–125

66–130 THORPE GAUGE for measuring either pressure of gas or rate of gas flow.
To read pressure of gas screw cap down over outlet at the top and connect gas supply to the inlet. Index on left scale gives reading of pressure in inches of water. With cap removed from outlet and gas allowed to flow through the gauge, the indicator registers on right hand scale the rate of flow of the gas in cubic feet per hour **$12.00**

SUBSTANCES FOR SPECIFIC HEAT DETERMINATIONS

66–170 LEAD CYLINDER with CONICAL TOP, weight approximately 650 grams **$0.65**

66–175 LEAD SHOT . . . . . Per Pound **.15**

66–177 COPPER SHOT . . . . . Per Pound **.56**

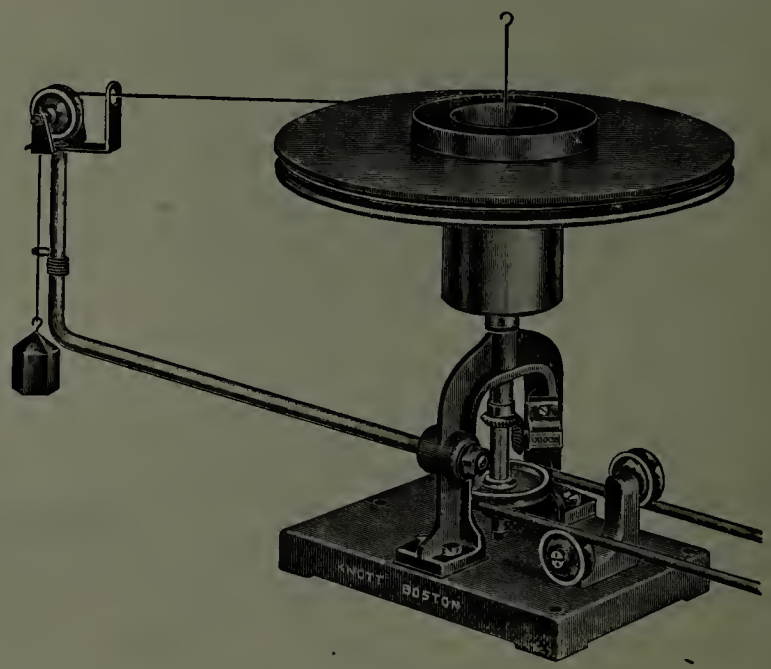
66–179 ALUMINUM SHOT . . . . . Per Pound **1.05**

66–181 GLASS BEADS . . . . . Per Pound **1.00**

No. 66–200

66–200 TYNDALL'S SPECIFIC HEAT APPARATUS for qualitative determination of the comparative specific heats of different metals.
The apparatus consists of a tripod on which is supported a disc of paraffine, 5 balls of different metals with handle for holding balls while heating them, and a tin plate for casting new paraffine discs. The balls may be heated either in boiling water, or by the flame from a Bunsen burner, or spirit lamp at the intersection of the rods bearing the balls.
Apparatus complete as above described **1.55**

MECHANICAL EQUIVALENT OF HEAT APPARATUS



No. 67-20

The design of the instrument was worked out at the Cavendish Laboratory in Cambridge. In operation it utilizes the principle of heating a given quantity of water by friction, both the water and the friction surfaces being placed in a carefully insulated calorimeter, all sources of error either being eliminated or accurately accounted for.

Until the outbreak of the European war this instrument was imported from Europe. As a product of our own factory we call particular attention to features of prime importance which have been taken into consideration in its manufacture.

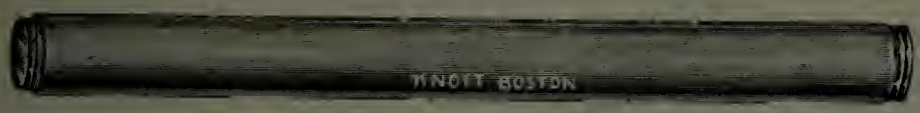
The vertical shaft is most carefully centered so that the friction unit rotates in a definite plane.

The tapered surfaces of the hollow truncated cones are hand finished to assure absolute uniform contact.

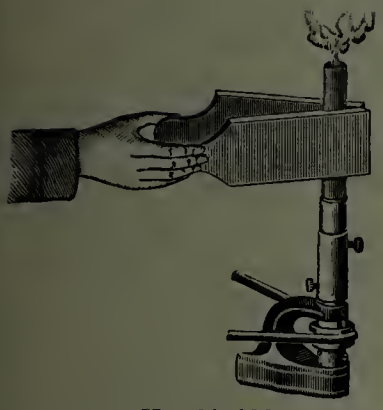
To prevent radiations, not only are the cones carefully insulated from the casing, but also an ample air jacket is provided.

Apparatus complete with detailed laboratory directions and ten feet Round Leather Belting with Patent Belt Fastener **$27.80**

For Drive Wheels and Driving Mechanism see Section 21



No. 67–25



No. 21–120

67–25 **DOUBLE INSULATION METAL CAPPED MECHANICAL EQUIVALENT OF HEAT TUBE,** after Millikan, Gale and Bishop (Experiment **20**).

This tube is a full meter in length, built up from heavy corrugated board covered inside and out with tough wrapping paper, thus affording ample air insulation.

The ends of the tube are closed by cork stoppers and close-fitting metal screw caps. This tube must not be confused with those of the cheaper construction **$0.70**

21–120 **TYNDALL'S HEAT BY FRICTION APPARATUS** for illustrating with Rotator the heat caused by friction on a brass tube while it is rotating rapidly **2.00**

No. 67–50

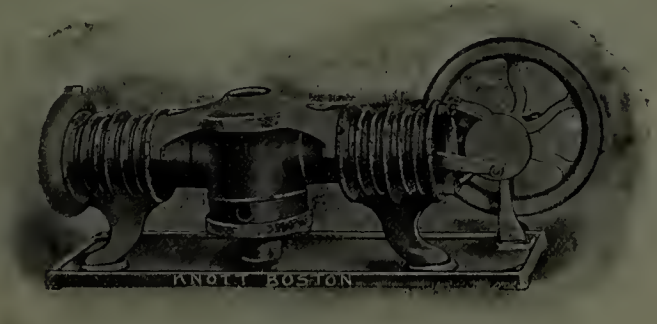
67–50 **FIRE SYRINGE,** illustrating the production of heat by the rapid compression of gases.

This apparatus consists of a heavy brass cylinder, about 20 centimeters long, provided with tightly fitting piston. On the end of this piston is a holder for a small piece of tinder. This cylinder is mounted on a convenient foot rest.

In use, a small tuft of tinder is placed in the holder on the piston and moistened with either ether or carbon disulphide that the experiment may be more effective. If now the piston is driven rapidly to the bottom of the cylinder, the compression of the air generates heat sufficient to set fire to the tuft of tinder.

Complete with piece of tinder **$1.75**

HOT AIR AND GAS ENGINES



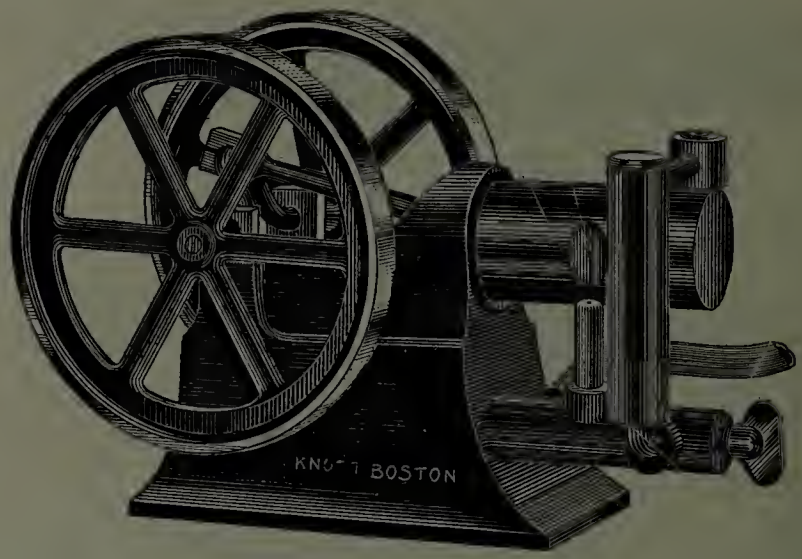
No. 68–15

68–15 **HOT AIR MOTOR** for use in schools and colleges in the study of air expansion motors; also readily adapting itself to the operating of small machinery models, etc.

This is an air-cooled motor with adjustable bearings and runs smoothly and silently. It is 18 inches long by 6 inches diameter, weight about 16 pounds. The fly wheel has a diameter of 6 inches and pulley of 1¼ inches.

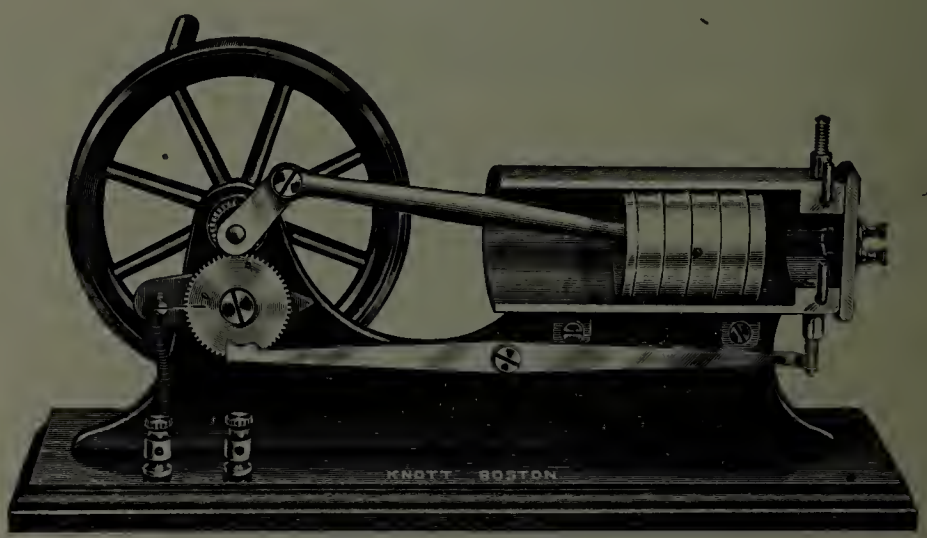
This engine may be run on either gas or alcohol and either types of burners will be supplied as requested **$15.00**

68–30 **HORIZONTAL HOT AIR ENGINE.** This is a design illustrating, in a similar manner as No. **68–15,** the principle of air expansion motors. It is of simple design, but will readily operate from the heat of a small alcohol lamp **3.75**



No. 68–40

68–40 **GAS ENGINE,** illustrating motive power, operated by gas explosion.
This is a small-sized model made of iron and brass. It is about 6 inches long, 3 inches wide, and weighs 3 pounds. Speed varies from 200 to 700 R. P. M.; enameled and nickel-plated.
This engine will be found an excellent model for demonstration.
Complete with directions **$3.15**



No. 68–50

68–50 **THE IMPROVED GAS ENGINE WITH SPARK ADVANCING AND SPARK RETARDING DEVICE.** The model above illustrated represents in section a four-cycle commercial gas engine. As may be noted, all parts are represented in their proper positions and may be shown in actual operation by merely turning a crank, the movement of parts being caused by a succession of gears.
The model is complete with all essential parts, — exhaust and intake valves, piston head, spark plug, etc., all being shown of sufficient size for classroom demonstration. By an ingenious method of construction partially noted in illustration we are enabled to show the proper moment of ignition giving rise to compression, if the secondary of a Ruhmkorff's coil be connected in series with the spark plug.
This engine is of rigid construction, scientific in every detail, and handsomely finished throughout, the finish of the different parts being such as to accentuate the parts desired. It is mounted on a neatly finished hardwood base **$7.50**

STEAM ENGINES

STEAM ENGINE MODELS

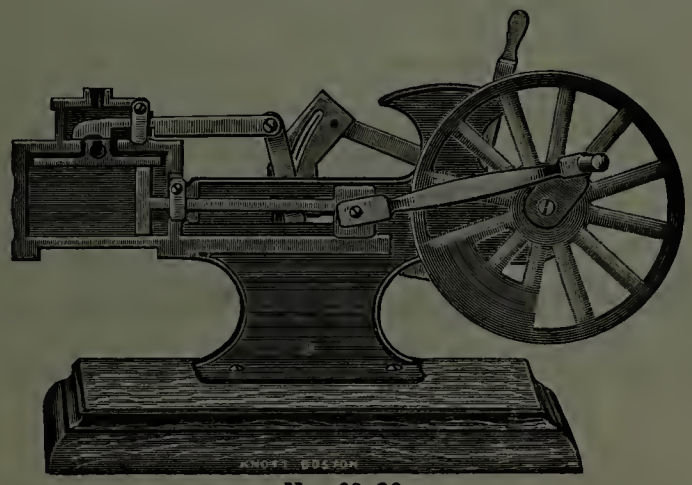
No. 69–10

No. 69–20

69–10 **WOLLASTON STEAM ENGINE,** a simple model to illustrate the expansive force of steam. This apparatus consists of a vessel as illustrated, in the neck of which is provided a close-fitting piston. In use water is placed in the bulb and heated until steam is formed. Steam will force the piston up the tube. If, now, the steam is condensed by plunging the bulb in cold water, the atmospheric pressure will force the piston back **$1.45**

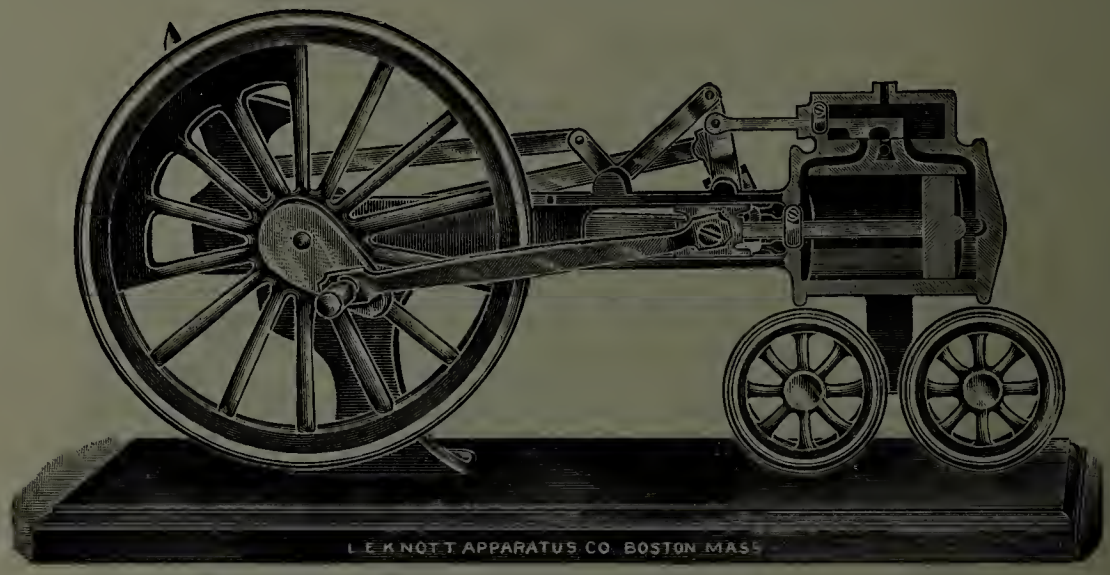
69–20 **STEAM CHEST MODEL.** This is an interesting model of a simple steam chest, demonstrating the opening and closing of the port holes by means of the slide valve.
The apparatus consists of a nickel-plated housing with glass window through which may be seen a working model of a steam chest. By means of a thumb screw at the back, the slide valve may be worked as desired, demonstrating the closing and opening of the port holes.
This is a handsomely finished instrument constructed on pedagogical lines. It will be found very valuable in the lecture hall in that, during the study of the large engines, this little instrument may be passed around the class **3.25**

SECTIONAL MODELS OF STEAM ENGINES



No. 69–30

69–30 **SECTIONAL MODEL OF A STEAM ENGINE.** A complete model of the locomotive showing clearly the movements of slide valve, piston, eccentric, reversal of steam by means of link motion and "cut off." All parts are carefully fitted and adjusted and have been finished to accentuate the different parts. Though the size is sufficient for class demonstration, it is advised that a pupil use this model for the study of the functions and relations of the different parts. As there is no complicated mechanism, the pupil's understanding of the steam engine is complete after a short study of the movements imparted to the different component parts by rotating the fly wheel a few times.
Mounted on a neatly finished wooden base **$2.65**



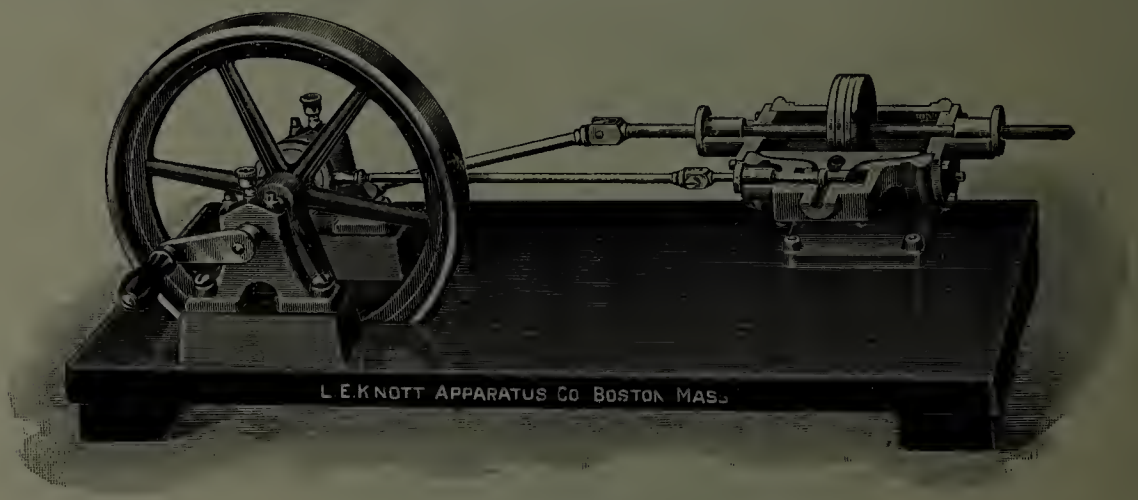
No. 69–35

69–35 **THE IMPROVED EIGHTEEN-INCH SECTIONAL MODEL OF A STEAM ENGINE.** This model takes the place of the 10-inch model which was formerly made. All the parts are, of course, correspondingly larger and, consequently, of correspondingly greater educational value, since the new model is designed for use on the lecture table.

Great care has been exercised in making all the parts in a form to resemble as nearly as possible similar parts in the commercial engine of locomotive type. The sectional view, as is indicated in the cut, shows the steam chest, cylinder, piston, and valves in vertical section through the center. Other features are shown sufficiently "off set" not to interfere with their resemblance to the actual working engine.

The size of this model, being 18 inches long and 9 inches high, renders it particularly well adapted to lecture table work. In order to assist in the easy differentiation of all the essential parts care has been exercised in the proper coloring so as to make the essential features stand out clear and sharp.

Engine is mounted on a substantial hardwood base, the entire instrument being finished so as to give the most pleasing appearance without interfering with its educational value **$6.75**

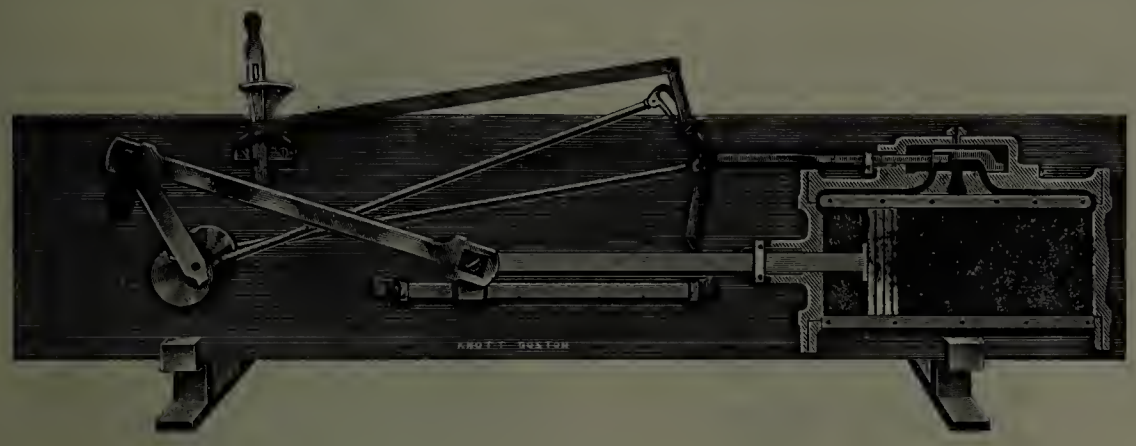


No. 69–40

69–40 **PROJECTION HORIZONTAL MODEL OF A STEAM ENGINE.** The working parts of this model are about the same size as the vertical model shown above, but so designed that they can be projected on the screen by means of the opaque projector, — a valuable feature, particularly in lecture rooms accommodating a larger number of students than can readily examine closely the 18-inch model.

The essential features are carefully differentiated by color effect so as to give the most striking appearance and easy differentiation on the screen.

The mounting is most substantial; workmanship is high grade throughout **$12.00**



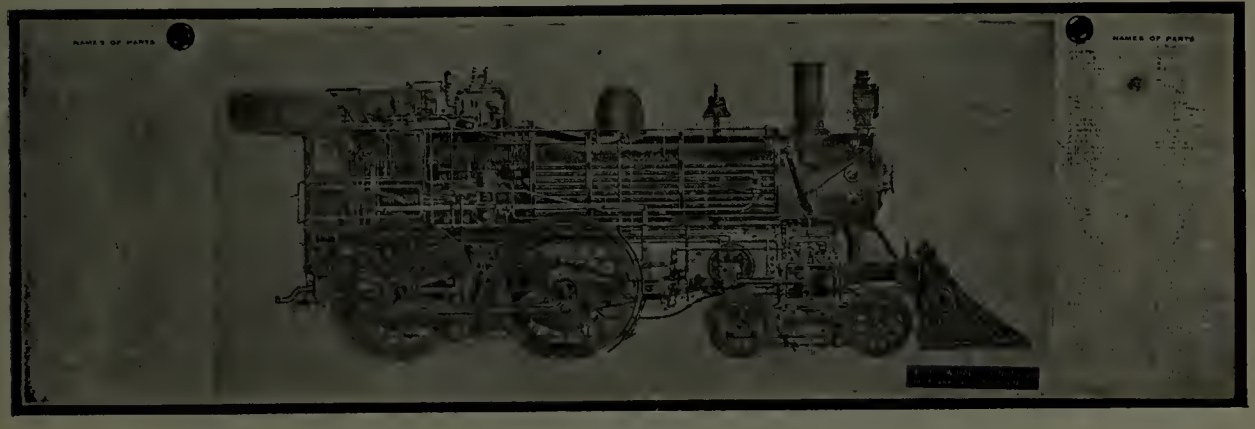
No. 69–50

69–50 **4-FOOT MODEL OF A STEAM ENGINE,** after design suggested by Mr. F. R. Miller, English High School, Boston, Mass.

This exceedingly large model has all the working parts of such generous proportions and open construction that every student in a large lecture hall will be able to see the essential features easily. It will thus be seen that this instrument in demonstration work will do for the large lecture room what No. **69–35** does for the small one.

The drive wheel or fly wheel has been omitted from this model, for the reason that it would of necessity be of such large proportions as to make the entire model altogether too difficult to handle and care for.

Complete as illustrated **$27.50**

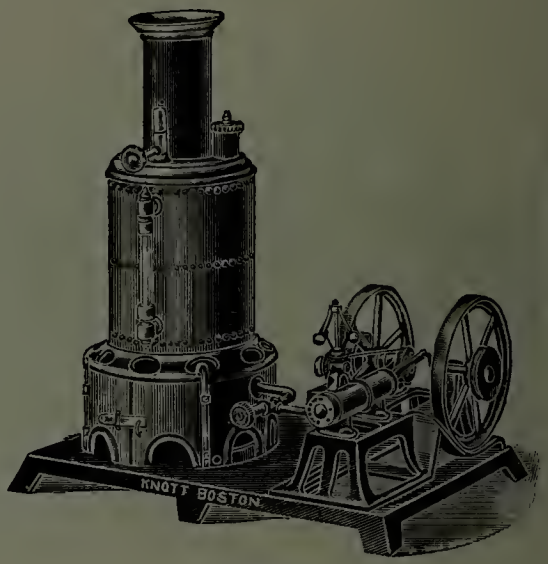


No. 69–55

69–55 **LOCOMOTIVE CHART,** designed particularly for hanging permanently on the wall of either lecture room or laboratory. The parts are so clearly indicated as to serve admirably for a detailed study of the parts of the modern locomotive. The sectional view shows 240 parts all named and numbered. It gives, in addition, complete information regarding the various details of steam engines in general and locomotives in particular.

Mounted on heavy cardboard with eyelets for hanging **$2.25**

No. 69–75



No. 69-85

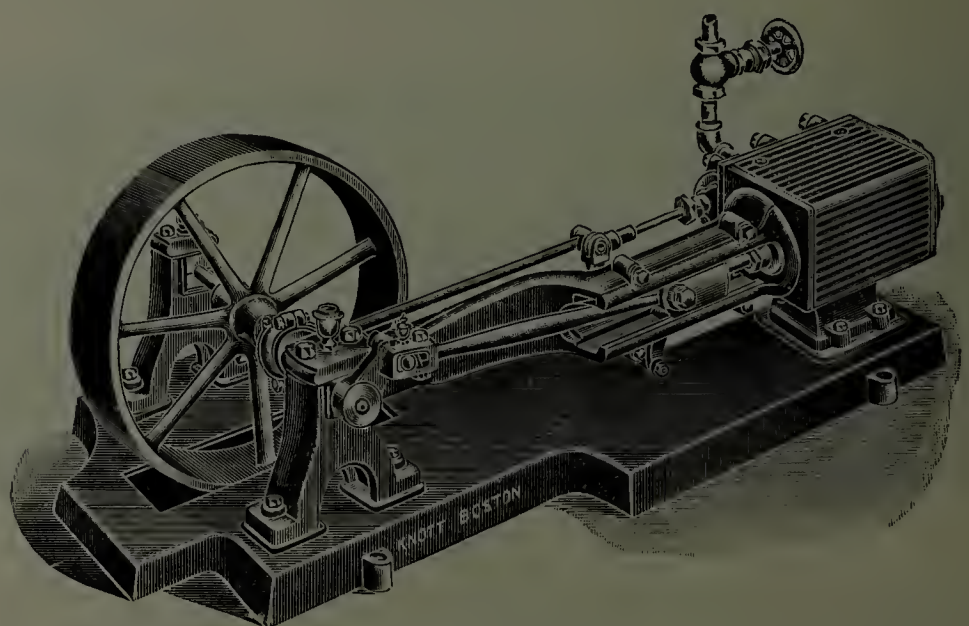
69–75 **WORKING STEAM ENGINE,** of small size, for use with Steam Boiler No. **60–365** and consequently designed to work on exceedingly low pressure, operating smoothly without load, on two inches of mercury pressure.

It is a compact, durably built, and substantial little engine. The fact that practically all schools are provided with inexpensive means of obtaining adequate steam pressure such as the Steam Boiler or Hypsometer above referred to, makes this engine of very wide use.

The mechanical or power advantage of working as a high or low pressure engine is readily demonstrated, the low pressure results being obtained either by connecting the exhaust to a condensing chamber, or working it in connection with the air pump.

As will be noted from the illustration, the engine is mounted on a substantial iron base, presenting very much the appearance of the commercial power engines **$4.85**

69–85 **WORKING MODEL STEAM ENGINE.** The model consists of a boiler and an engine both mounted on a nickel-plated iron base the edges of which are polished. This engine runs rapidly and easily, each engine being thoroughly tested before packing and fully warranted. Complete with explicit directions for use and care, in a wooden lock corner box **7.40**

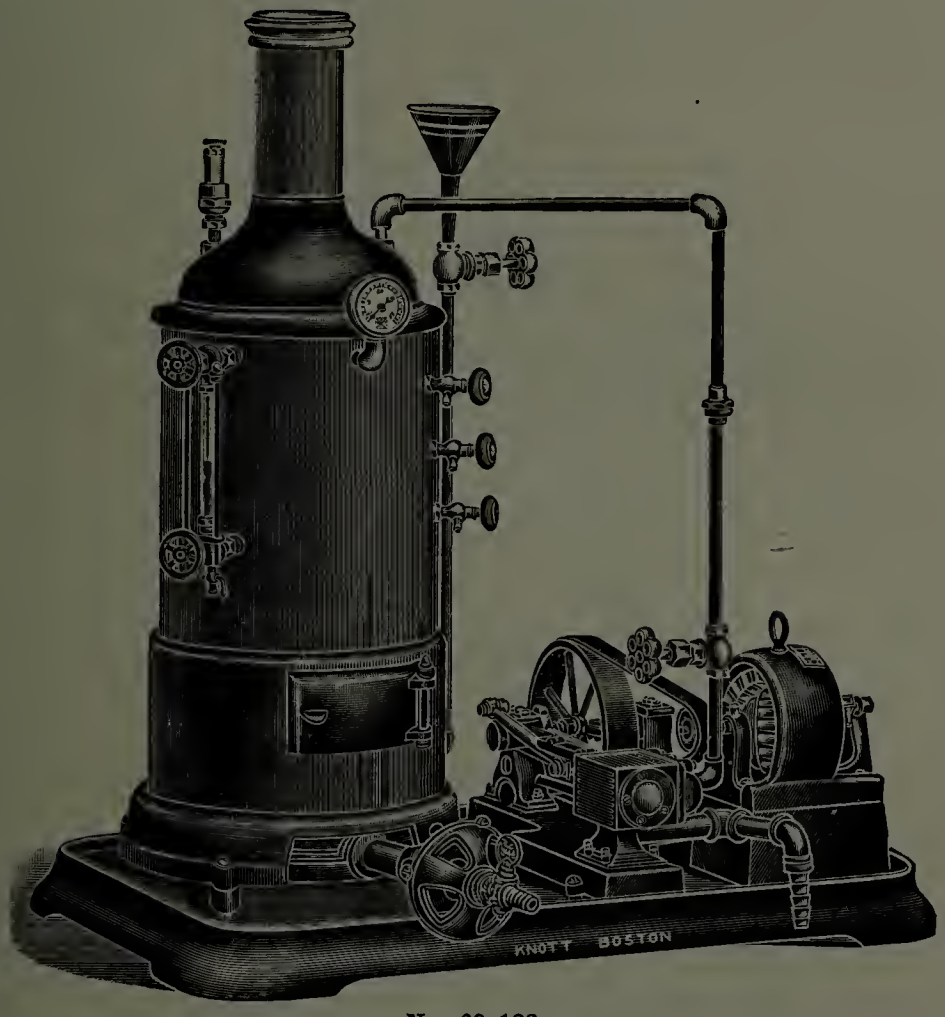


Nos. 69–115 to 69–117

69–115 **ONE-QUARTER HORSE-POWER HORIZONTAL CORLISS ENGINE,** cylinder 1⅛ × 2 inches; bed 12 inches long by 7 inches wide; fly wheel 6 inches in diameter **$24.50**

69–117 **ONE-HALF HORSE-POWER HORIZONTAL CORLISS ENGINE,** cylinder 1¾ × 3 inches; bed 23½ inches long by 13½ inches wide; fly wheel 10 inches in diameter by 2-inch face; approximate weight 40 pounds **55.00**

STEAM POWER PLANTS



No. 69–122

69–120 STEAM BOILER AND ENGINE. The pedagogic merit of a working demonstration Steam Boiler and Engine of commercial type and of sufficient power to be of practical value will be readily appreciated. Models are excellent and perhaps necessary, but the wide-awake student is not satisfied. He desires an actual operating machine of commercial type.

Our outfit, weighing 175 pounds, consists of a commercial ¼ H. P. Engine mounted on same base with, and connected to, a commercial ¼ H. P. Boiler.

The Engine is of the standard Corliss Type, cylinder 1⅛ inches by 2 inches; bed 12 inches long by 7 inches wide; fly wheel 6 inches in diameter. It is carefully designed, and no efforts are spared in its construction to make a practical engine of pleasing appearance. It is provided with attachments to take up wear and maintain adjustments.

The Boiler is of the Vertical Tubular Type, 10 inches in diameter, height over all 21 inches, with a water jacket fire-box and twenty ¾-inch seamless drawn brass tubes, each 10½ inches long. Shell is of 3/16-inch wrought iron, lap welded, the upper and lower parts of best grade iron; the casing and the stack are of Russia iron, a thoroughly practical machine tested to 200 pounds per square inch. Steam pressure up to 80 pounds may be utilized. It is equipped with gas burner of ample size, adapted especially to the work.

(For further description and price see following page).

The Base is of cast iron of ample dimensions for both Boiler and Engine. It is neatly finished. Engine and Boiler are firmly attached and all connections made. The boiler is completely equipped with necessary valves and gauges so that all that is necessary to start operation is to fill the boiler with water to the proper height as seen by the water gauge, connect burner to gas main, and generate the steam.

Illustration is that of No. **69–122** following, but the outfit described under this number is the same as illustration except that dynamo is not furnished **$74.50**

69–122 STEAM AND ELECTRIC POWER PLANT. Frequent calls have been made for an outfit which would illustrate the generation of electric power. By referring to the illustration it will be noted that we have attached on the same base with the engine and boiler above listed a generator of sufficient capacity to demonstrate the principles involved. This generator is of commercial type, 36 watts capacity (6 volts, 6 amperes). It is direct belted and even with the small pressure of 30 pounds may be run to its full speed of 2200 R. P. M.

Power Plant complete, as illustrated **88.75**

STEAM BOILERS

The commercial type engines previously listed, pages 236 and 237, require steam pressure. To satisfy this requirement we offer one-quarter and one-half H. P. boilers of a convenient size and commercial type selected from this country's manufactures as having the best educational value. Each boiler is equipped with a steam gauge and safety valve, a water gauge and three gauge cocks, with valves on steam and water pipes.

Steam boilers of this type are given a prominent place in laboratories where the practical nature of Physics is stressed. The two sizes below develop energy sufficient to run the ordinary demonstration models. Larger sizes will be quoted and furnished on application. Each boiler is complete with burner all ready for connection to source of gas supply and since they are tested to withstand pressures of practically one hundred per cent. beyond pressures ordinarily required, there is positively no danger in continuous use, especially since each boiler is equipped with a safety valve.

Installations have been made and these boilers have been found entirely satisfactory in the following ways:

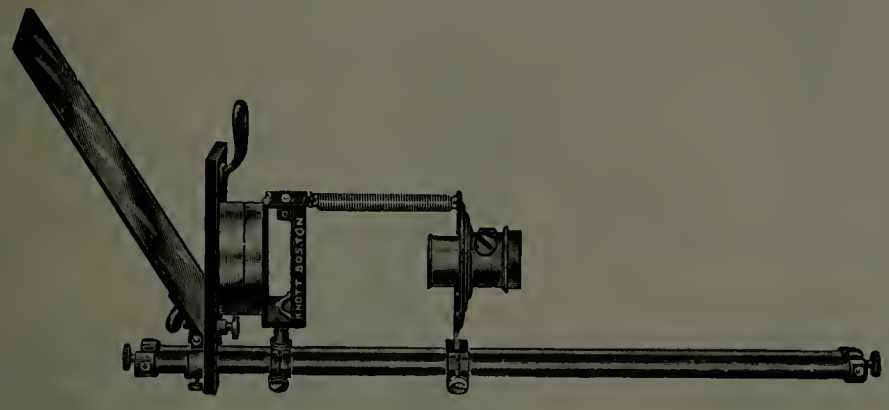
1. Study of generation of steam and the value of its energy commercially, as the motive force in running engines, etc.
2. Study of boiler construction as employed commercially.
3. Study of functions of each attachment, valves, cocks, gauges, safety valves, etc., and why necessary.
4. Study of Bourdon Gauge in actual use.
5. Determining temperature of live steam.
6. Source of live steam for a great number of practical experiments in Physics, Chemistry and Biology. As a source for experiments illustrating rise in boiling point due to increase of pressure, source in determining expansion coefficient, a source for running steam baths in chemistry, in distillations, in evaporations, etc., etc., these boilers will be found of exceptional value.

69–125 ONE-QUARTER HORSE-POWER BOILER, selected as best adapted not only to furnish steam pressure to run our Steam Engine No. **69–120,** but as a boiler of complete adaptability to general purposes. Complete with improved Gas Burner **$37.75**

69–130 ONE-HALF HORSE-POWER BOILER, similar to above. Complete with improved Gas Burner . **63.00**

LIGHT

SOURCES OF LIGHT



No. 70–10

70–10 HELIOPTICON OR SUNLIGHT PROJECTOR. This instrument consists of a square metal plate in which is fitted a large flat ring to which is fastened a long mirror by special patent hinge. This mirror is arranged for adjustment to any angle with the plate by a large screw which passes through the lower portion of the ring. This ring also carries a condensing lens, in cell, and a metal handle by which the ring and its attachments are turned in a vertical plane. A combination of movements enables the mirror to be adjusted to reflect a beam of sunlight in one direction and keeps it in position with but slight attention. Two parallel tubes pierce the metal plate below the ring and are held firmly by clamping screws. This tube track forms a light but rigid bench for the slide stage and objective carrier. It may also be used for an optical bench.

Heliopticon as above described, including ¼-size objective, one 4½ inch condensing lens, and slide carrier $25.00

70–15 PORTE LUMIERE for securing parallel beams of light. This instrument is a "Sunlight Projector" 9.00

No. 70–20

70–16 ADJUSTABLE SLIT DIAPHRAGM for use with heliopticon for securing a rectangular beam of light 1.50

70–17 CYLINDRICAL DIAPHRAGM for use with heliopticon with five graded openings for securing pencils of light 1.50

70–20 UNIVERSALLY ADJUSTABLE HELIOSTAT WITH CLOCK WORK. The instrument illustrated pictures a heliostat capable of universal adjustments to any position. It is manufactured by one of the leading instrument makers of Europe whose guarantee is sufficient recommendation of its quality. It is handsomely finished throughout and capable of very efficient service. Diameter of mirror 10 centimeters. With each heliostat is furnished a black and a silvered mirror and, in addition, a secondary mirror on stand.
Duty Free 74.00

70–22 HELIOSTAT, same as above, but diameter of mirror 5 centimeters . . . . . Duty Free 54.00

PARAFFINE CANDLES for use in photometric work as source of light.
These candles are of standard quality and are furnished in two sizes:

70–50a Sixes (six to the pound) . . . . . Per Dozen .33

70–50b Twelves (twelve to the pound) . . . . . Per Dozen .20

STANDARD CANDLES. See Section 71.

No. 70–70

No. 70–90

No. 70–92

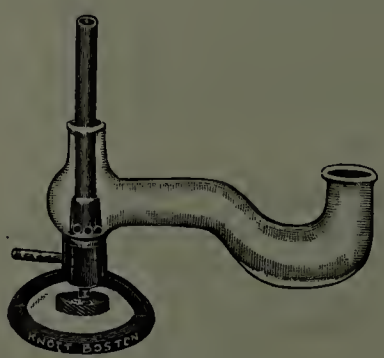
70–70 **KEROSENE LAMP AND METAL BOUND ASBESTOS CHIMNEY** for furnishing source of light in photometric experiments.
This consists of a small brass kerosene lamp, with wick and chimney. In order to furnish merely a beam of light and not diffused rays, an asbestos chimney with small opening is supplied in addition to the glass chimney $0.50

70–72 **KEROSENE LAMP** only, with wick and glass chimney $0.32

70–73 **METAL BOUND ASBESTOS CHIMNEY,** only 18

70–90 **ILLUMINATING BURNER FOR GAS** for laboratory tables. Consists of a burner tube 12 inches high mounted on heavy iron base . .80

70–92 **LOW FORM ILLUMINATING BURNER,** curved tube fitted with illuminating tip.
This burner will be found very convenient for use with optical benches .55



No. 70–95

70–95 **MONOCHROMATIC FLAME BURNER.** Gases of various substances generate in the glass cell and intermingling with the illuminating gas give to the Bunsen flame the distinct monochromatic flame desired.
Complete as illustrated $2.25

70–110 **ELECTRIC LAMP,** table size, adjustable from 12 to 18 inches, made of polished brass, nickel-plated.
Complete as illustrated 9.75

70–112 **GAS LAMP,** similar to above, but arranged for burning illuminating gas.
Complete with Argand Burner and six feet of rubber tubing, with goose-neck connection, stand adjustable from 12 to 18 inches . . . 9.75

70–115 **KEROSENE LAMP,** similar to above, but arranged with reservoir for oil.
Complete 9.75

No. 70–110

LILLIPUTIAN PROJECTING LAMP

Nos. 70–125 to 70–126

The Lilliputian Projection Lamp was designed for the purpose of giving an intense beam of parallel rays especially suited for work in the physical lecture room. It has also been adapted for transparent projections for use where ready and easily operated lantern outfit is desired. The occasion for offering this apparatus arose from the difficulty of handling larger outfits in a way to most readily give desired results in physical experiments.

A Projection Lantern using from 12 to 15 amperes of current must necessarily require a rheostat of ample proportions, a housing for the lamp designed to properly care for the heat generated, and a condensing system of sufficient size for producing a picture from 12 to 16 feet in diameter at considerable distance from the lamp. It is apparent that an apparatus designed for this work cannot be readily used on the lecture table where an intense, small parallel beam of light only is required. To meet this requirement, a small lamp with automatic feed is supported with a simple rheostat on an adjustable upright stand.

The condenser, being small and placed close to the arc, uses a relatively large proportion of the light rays. The rays emerging from the condenser are parallel, forming an intense beam about 3 centimeters in diameter.

The current required is only 1.5 amperes at 110 volts pressure. The form of lamp above illustrated can only be furnished for direct current.

The great variety of uses to which such an apparatus can be put will be apparent at once to those who have long felt the need of such a source of light in lecture table work. As may be noted, the instrument is entirely self-contained. The housing is adjustable in height. The necessary resistance is mounted on one of the legs of the tripod base and binding posts for connections to circuit on the other legs. Close observation of scientific requirements has enabled the manufacturers to furnish a lamp that may be readily moved from place to place, — one that allows of universal adjustment both as to position of lamp and direction of the rays of light proceeding from the apparatus.

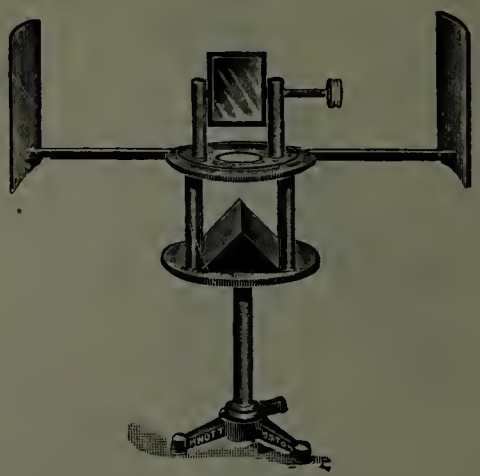
Although exceedingly compact, renewal of carbons is simple. Their position within the housing is readily noted through the window provided.

70–125 **LILLIPUTIAN PROJECTION LAMP,** as illustrated, with resistance on stand for direct current of 1.5 amperes at 110 volts, with ten extra carbons . . . . . Duty Free . . .

70–126 ——, same as above, but with resistance for 220 volts D. C . . . . . Duty Free . . .

PHOTOMETRIC AND OPTICAL BENCHES

PHOTOMETERS

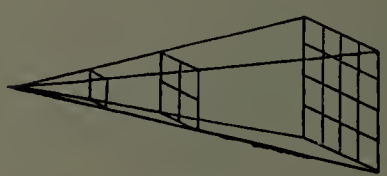


No. 71–10

71–10 RITCHIE PHOTOMETER for lecture room demonstration.

So little attention has been given to class demonstrations in Photometry that we believe our design will meet with universal approval. A photometer head is provided with a prism, on the faces of which light from two different sources can fall. A movable ring with two uprights which support a tilting mirror on horizontal axis may be turned in all directions that pupils in all parts of the room may test the equality of illumination on both faces of the prism. Light shields are provided to obstruct rays from the two sources of light striking the tilting mirror.

Complete as illustrated, mounted on stand **$9.75**



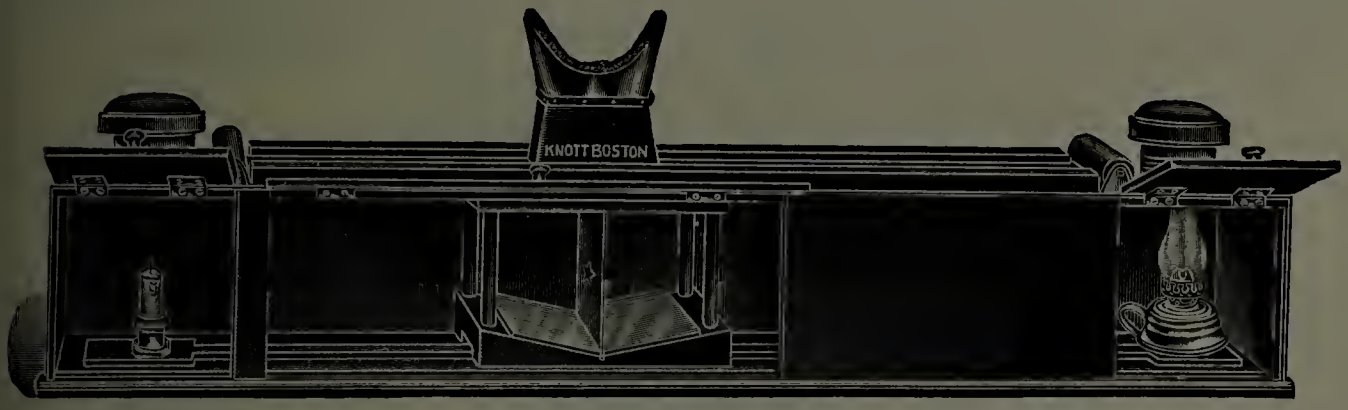
No. 71–20

No. 71–30

71–20 INVERSE SQUARES MODEL for illustrating that the intensity of the illumination at a surface due to a given source of light is inversely proportional to the square of the distance of the surface from the source of light.

The apparatus consists of a wire frame constructed as illustrated, with a maximum axis of 8 inches. Distances from the source may readily be measured and from the counting of the equal squares the law may readily be formulated. This is a simple pedagogical model which at once brings to the pupil the formulation of a law which oftentimes is particularly abstruse **$1.80**

71–30 CAMERA OBSCURA, or PIN HOLE CAMERA, for illustrating images produced through a small aperture. This camera consists of a rectangular box with pin hole opening in front and a second telescoping box with ground glass plate for receiving the image . . . . . **.65**

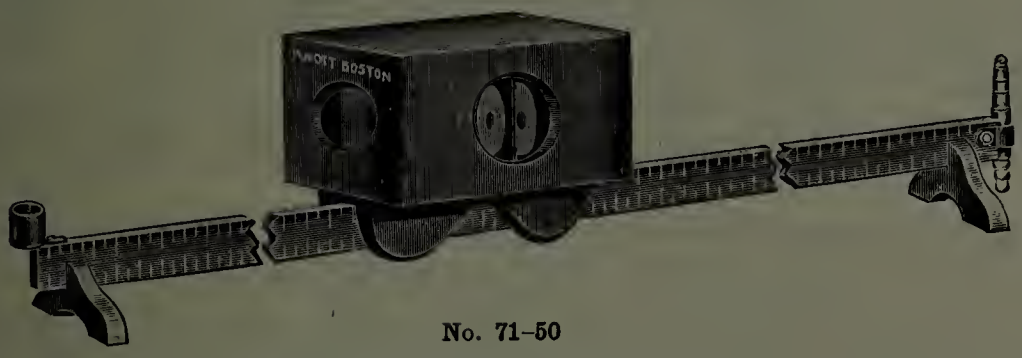


No. 71–40

71–40 **LIGHT-ROOM DIBDIN-BUNSEN PHOTOMETER** for determining the relative intensity of two sources of light without the necessity of darkening the room.

This improved form consists of a light proof box in which at each end within separate compartments are situated the sources of light. Between these sources slides the Dibdin-Bunsen Screen, mounted in substantial holder connected as a part of the eye-shade as noted in the illustration and moving with it. This Eye-shade and Screen Holder are fastened at either end by narrow opaque spring-roller-bands attached to the Photometer Box in such a manner as to prevent light from entering the Box. Doors are provided for access to either source of light or to the Dibdin-Bunsen Screen.

Without light sources **$13.75**



No. 71–50

71–50 **STUDENT'S PHOTOMETER** for determining by direct comparison with a standard the intensity of a source of light.

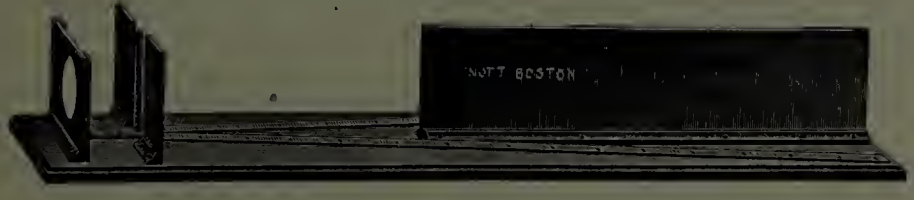
The apparatus consists of a graduated rod at one end of which is attached a candle holder; at the other a gas tube with tip. The rod is mounted on metal supports as illustrated in the apparatus of No. **22–160.**

The photometer box with indicator is fitted with a Bunsen screen, Dibdin's modification, placed between two mirrors fixed at such an angle that both sides of the screen can be viewed simultaneously from the front.

This will be found a typical student's instrument, capable of a fair degree of accuracy. Complete as illustrated **$3.50**

71–52 **ELEMENTARY BUNSEN PHOTOMETER,** simple form complete with Meter Stick, Supports for same, Simple Bunsen Screen and Holder, Support for one and Support for Four Candles. Complete **1.00**

71–53 **JOLLY PHOTOMETER HEAD** after Fuller and Brownlee (Experiment **37**), for use on Meter Stick **2.00**



No. 71–60

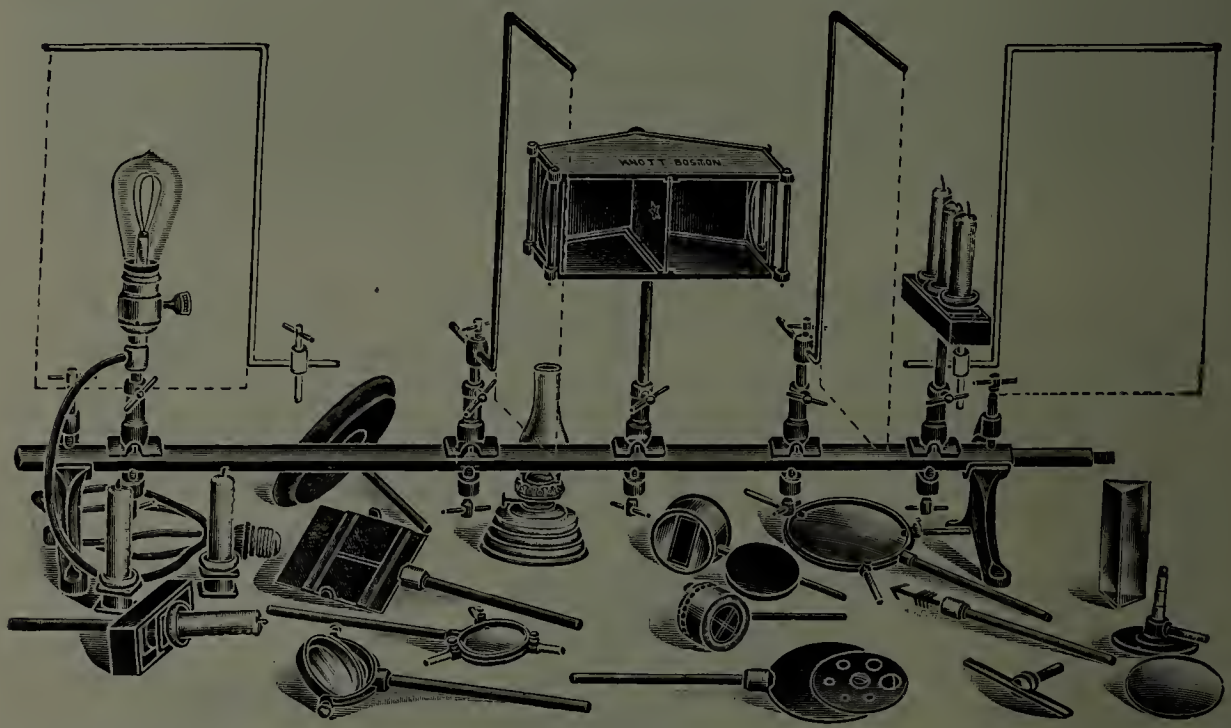
71–60 **RUMFORD'S PHOTOMETER** for determining the relative intensity of two sources of light.

This Photometer consists of a wooden base board upon which are mounted two converging meter sticks. At the point of convergence is mounted a blackened rod, designed to cast a shadow on the opaque screen held in the vertical support as illustrated at the extreme left hand side. Two screens fixed vertically on either side of the rod are designed for obstruction of all extraneous light. The sources of illumination are mounted on a base board, one on either side of the light shield.

Complete as illustrated **$3.50**

GENERAL PHOTOMETRIC OR OPTICAL BENCH ATTACHMENTS

PHOTOMETERS



71–100 CAST-ALUMINUM DIBDIN-BUNSEN PHOTOMETER for use as a comparison head in determining candle power of a source of light.

This photometer is a modification of the standard Bunsen Screen. In the Bunsen Screen the translucent and opaque portions do not transmit light equally. The grease spot, therefore, even when equally illuminated, is never entirely lost. The Dibdin's modification consists in exposing a star of translucent paper mounted in heavier paper of the same texture. This screen is mounted between two mirrors at such an angle within a cast metal box that both sides of the screen may be seen simultaneously. This cast metal box is mounted on a 10-millimeter rod for use with No. **5–810** Clamp. It is blackened inside and out.

The results possible with the Dibdin's modification are accurate and quickly obtained. We desire also to emphasize the advantage of our cast-metal casing over the sheet metal forms **$4.75**

OPTICAL BENCH CANDELABRUM AND DRIP CUP, for use with No. **5–810** Clamp as a candle holder on an optical bench "built up" from rods and clamps.

In the design of our Candelabrum we have overcome the objectionable features of the various types on the market. We are enabled to center candles in groups of one, two, three, and four, almost instantly.

This design consists of a cast metal trough mounted on a rod of size for use in No. **5–810** Clamp. The Individual Candle Holder is a casting with drip cup that fits into the trough with a sliding fit. Any or all the Holders may be readily moved laterally in the trough to properly center the light.

71–125 CANDELABRUM TROUGH, mounted on a 10-millimeter rod, for use with No. **5–810** Clamp . . **$0.60**

71–127 INDIVIDUAL CANDLE HOLDER, for holding candles . . . . . **.15**

70–72 BRASS KEROSENE LAMP, WICK, AND CHIMNEY, for use on table top No. **71–250** . . . . . **.32**

71–135 LUMINOUS BURNER, especially designed for use with No. **71–210** T. & H. Light Box with Wire Screen . . . . . **.45**

71–140 INCANDESCENT LAMP HOLDER, mounted on rod with attachment for connection to the standard Edison socket.
Without lamp cord and Edison plug . . . . . **.95**

71–142 MOUNTED WELSBACH GAS MANTLE **1.35**

71–180 MOUNTED CONVEX GLASS MIRROR. This is a convex mirror, 3 inches in diameter, focus 6 inches, adjustably mounted in an improved holder for use with our No. **5–810** Right Angle Clamp **2.60**

71–182 MOUNTED CONCAVE GLASS MIRROR. This is a concave mirror, 3 inches in diameter, focus 6 inches, adjustably mounted in an improved holder for use with our No. **5–810** Right Angle Clamp **2.60**

5–960 ADJUSTABLE PLANE MIRROR ON ROD, mirror 50 millimeters in diameter, adjustable in stirrup about a horizontal axis, adjustable on rod about a vertical axis. Mounted on nickel-plated rod 15 centimeters long, for use with our No. **5–810** Clamp **1.95**

OPTICAL BENCHES

71-190 **SCREEN WITH APERTURES.** This is a metal screen on which is mounted a revolving disc with apertures of different sizes. By revolving the disc these various sizes of holes center over the large hole on the screen. It is mounted on a rod ready for use with No. **5-810** Clamp **$3.30**

71-195 **SCREEN WITH ADJUSTABLE VERTICAL SLIT.** This is a metal screen with a two-part metal slide which may be varied at will to secure a slit of any width up to one inch. Mounted on rod ready for use with No. **5-810** Clamp **3.30**

71-200 **SCREEN HOLDER,** large size, for holding large pieces of cardboard, sheet gauze, etc. . . . . **.75**

71-205 **SCREEN HOLDER,** small size, for holding small pieces of cardboard, sheet gauze, etc. . . . . **.65**

71-210 **T. & H. BOX WITH WIRE SCREEN,** for use in determining the conjugate foci of a converging lens. This box is especially designed to hold a source of light. It consists of a metal box in one face of which is a slit covered by a wire screen. It is finished dead black throughout . . . . . **.90**

71-215 **EYE-SHADES,** for use on a photometer bench when it is desired to shade the eyes as well as the front of the screen from rays from the sources of light. They consist of a pair of black cloth shades suitably mounted for use with No. **5-810** Right Angle Clamp . . . . . Pair **1.30**

71-225 **GRADUATED CARDBOARD SCREEN, 10 × 10 centimeters,** for use with No. **71-200** or **71-205** Screen Holder . . . . . **.10**

71-227 **BLACK OPAQUE SCREEN, 10 × 10 centimeters,** for use with No. **71-200** or **71-205** Screen Holder . . . . . **.20**

71-230 **TRANSLUCENT OR OPALESCENT SCREEN, 20 × 20 centimeters,** for use with No. **71-200** Screen Holder . . . . . **.28**

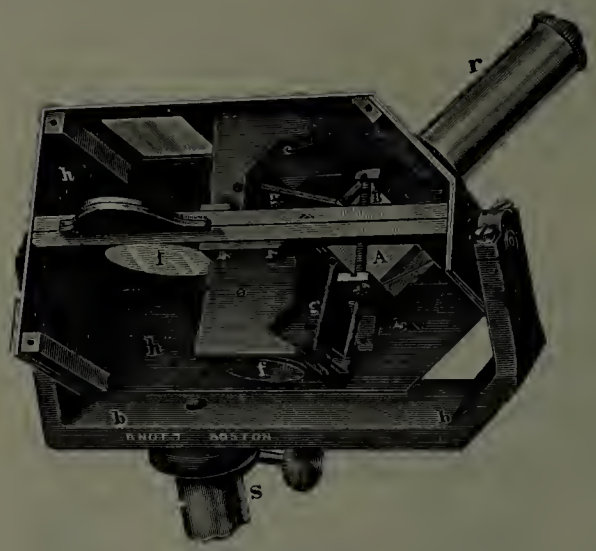
71-235 **CARDBOARD METRIC SCALES** for use with No. **71-205** Screen Holder in determining the magnifying power of a convex lens. A 5-centimeter and a 10-centimeter section of a metric scale are mounted on cardboard, the centimeter lines of one ruled in red, in black on the other. Per Pair . **.10**

5-970 **UNIVERSAL LENS HOLDER** for lenses up to 4 inches in diameter. This ingenious holder is adjustable by means of the rods and set screws to hold and clamp firmly, in or off center, lenses up to 4 inches in diameter. Handsomely oxidized black with nickel-plated rod. (See illustration, Section **5**) . . . . . **.88**

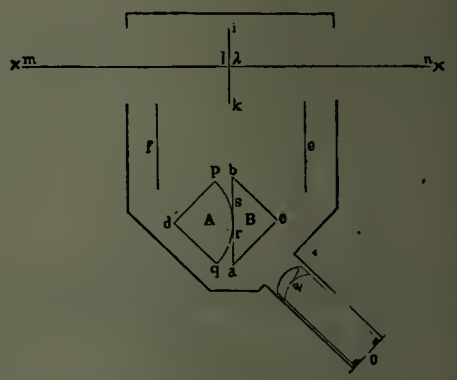
5-975 ——, same as above, for holding lenses up to 2 inches in diameter . . . . . **.78**

71-250 **TABLE TOP ON ROD** for general use in supporting objects on optical and photometric benches **1.16**

71-255 **IMAGE ON ROD** for use with No. **5-810** Right Angle Clamp . . . . . **.65**



No. 71–260



No. 71–260 (Sectional View)

71–260 LUMMER-BRODHUN PHOTOMETER. This is a modification of the grease spot photometer. Light from the two sources falls upon the screen **ik** (see illustration), made of two sheets of paper with tinfoil between, and placed perpendicular to the direction of the optical bench. The diffused light emitted by these screens falls on two totally reflecting prisms and thence on to the faces **bc** and **dp** of the two prisms **A** and **B**. The part **rs** of the prism **A** which touches **B** is plane so that all light falling on **rs** is transmitted. The eye placed at **O** thus receives from the side **m** only light which passes through the ring **rs** and from the side **n** only light which is totally reflected from the surfaces **ar** and **bs**. The eye thus sees a bright or dark spot within a uniformly bright circle. When the photometer is so adjusted that **e** and **f** receive the same amount of light, the round circle of light entirely disappears.

This photometer box is mounted in a frame on rod designed to fit our No. **5–810** clamp for use on an optical bench . . . . . Duty Free **$36.00**

STANDARD SOURCES OF LIGHT

Nos. 71–269 and 71–270

71–265 HEFNER LAMP, approved by the Physikalisch-Technischen Reichsanstalt as the German Photometric Standard Source of Light, burning amyl-acetate. **With flame measure,** after regular type, wick regulator and shears . . . . . Duty Free **$12.50**

71–266 ——, same as above, with certificate of the Physikalisch-Technischen Reichsanstalt . . Duty Free **16.50**

71–267 HEFNER LAMP, with Flame Measure after Hefner-Alteneck, wick regulator and shears. Duty Free **12.50**

71–268 ——, same as above, with certificate of the Physikalisch-Technischen Reichsanstalt . . Duty Free **16.50**

71–269 HEFNER LAMP, with Flame Measure, after regular type **and also after Hefner-Alteneck,** wick regulator, and shears . . . . . Duty Free **19.50**

71–270 ——, same as above, with certificate of the Physikalisch-Technischen Reichsanstalt . . Duty Free **24.50**

71–271 AMYL-ACETATE, C. P., for burning in the Hefner Lamp . . . . . Per Pound **1.80**

71–272 STANDARD CANDLE, for use as photometric standard, made of sperm, six to the pound, will burn 120 grains (7.776 grams) per hour . . . . . Each **.25**

NOTE. No. **71–250** Table Top on Rod is used as holder for above sources of light.

No. 98–141

No. 98–142

Nos. 64–100 to 64–110

98–142 **MOUNTED SELENIUM CELL.** For description see Section **98** **$14.00**

98–141 **SELENIUM CELL.** Same as above but unmounted. For description see Section **98** **11.50**

64–100 **IMPROVED MINERALITE THERMOPILE "A."** For description see Section **64** **11.75**

64–110 **IMPROVED MINERALITE THERMOPILE "B."** For description see Section **64** **14.50**

5–50d **SQUARE SUPPORT ROD, ungraduated,** 19 millimeters square × 100 centimeters long **2.30**

5–50f ——, same as above, 19 millimeters square × 200 centimeters long **4.45**

5–55a **SQUARE SUPPORT ROD, graduated** to millimeters, 19 millimeters square × 100 centimeters long **6.50**

5–55b ——, same as above, 19 millimeters square × 200 centimeters long **10.75**

5–810 **RIGHT ANGLE CLAMP,** for holding two rods in same plane but at right angles to each other . **.68**

5–375 **END SUPPORTS,** especially designed for holding bed-rod of optical benches. Extreme care is exercised in machining these supports so that they will suit all requirements . . . . . Each **.55**

PHOTOMETRIC AND OPTICAL BENCH OUTFITS

(Attachments included in the following outfits are illustrated on pages 244 and 245.)

For the convenience of those teachers who desire to order their Photometric or Optical Bench Outfits complete, we list the following, which in use have been found most satisfactory.

71–327 **UNIVERSAL TWO-METER PHOTOMETRIC OUTFIT WITH GRADUATED ROD,** for use with incandescent lamp as standard, complete as follows:

1 pair End Supports
1 Graduated Two-Meter Rod
1 Dibdin-Bunsen Photometer on Rod
1 Incandescent Lamp Holder on Rod
1 Welsbach Gas Mantle on Rod
3 Right Angle Clamps
Complete **$20.94**

71–327A ——, same as above, but with ungraduated rod **14.64**

71–329 **UNIVERSAL ONE-METER PHOTOMETRIC OUTFIT WITH GRADUATED ROD,** same as No. **71–327,** but Graduated Rod is but one meter long **16.69**

71–329A ——, same as above, but with ungraduated rod **12.49**

71–331 **UNIVERSAL TWO-METER PHOTOMETRIC OUTFIT WITH GRADUATED ROD,** complete as follows:

1 Pair End Supports
1 Graduated Two-Meter Rod
1 Dibdin-Bunsen Photometer on Rod
1 Pair Eye-Shades
1 Candelabrum Trough on Rod
4 Individual Candle Holders
1 Incandescent Lamp Holder on Rod
5 Right Angle Clamps
Complete **23.45**

71–331A ——, same as above, but with ungraduated rod **17.15**

71–332 **UNIVERSAL ONE-METER PHOTOMETRIC OUTFIT WITH GRADUATED ROD,** same as No. **71–331,** but Graduated Rod is but one meter long **19.20**

71–332A ——, same as above, but with ungraduated rod **15.00**

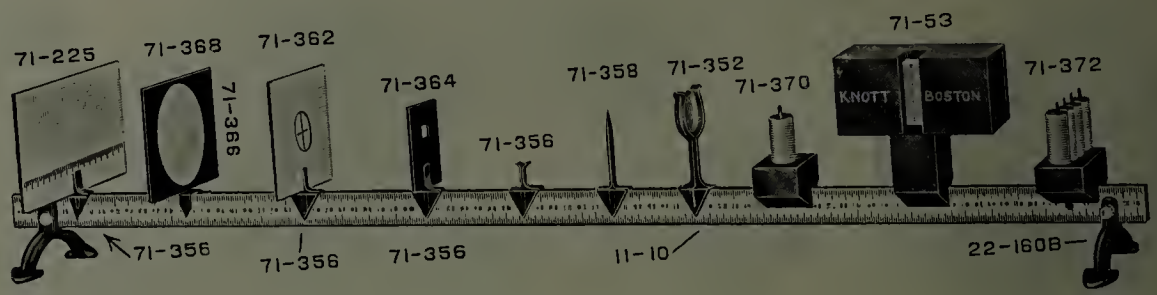
OPTICAL BENCHES

The above outfits, with the additions of a few attachments found on pages 244 and 245, will constitute excellent optical benches.

We recommend the following additions to any of the above outfits.

71–340 **OPTICAL BENCH ATTACHMENTS,** consisting of Screen Holder, Graduated Opaque Screen, Black Opaque Screen, Translucent Screen, Image on Rod and Lens Holder for lenses up to 4 inches in diameter **$3.56**

Lenses, Section **74**. Prisms, Section **74**. Mirrors, Section **72**. Candles, Section **70**.



71-350 **STUDENTS' OPTICAL BENCH,** a simple outfit for optical experiments by students. The apparatus is shipped complete with meter stick, a lens holder, one lens with finished edges, 1½ inches diameter, 15 centimeters focus, a pin holder, pair of metal supports for meter stick, screen holder, and cardboard screen $1.10

SIMPLE PHOTOMETRIC AND OPTICAL ATTACHMENTS

11-10 **METER STICK** $0.28

71-352 **LENS HOLDER** 11

74-121 **LENS,** 1½ inches diameter, 6 inches focus 24

22-160b **METAL SUPPORTS FOR METER STICK** . . . . . Per Pair .25

71-356 **SCREEN HOLDER** 08

71-225 **GRADUATED CARDBOARD SCREEN** 10

71-358 **PIN HOLDER** 08

71-375 **BLOCK AND BENT WIRE** for finding real and virtual images in a lens. This is the standard piece so frequently called for in the many manuals in use among secondary schools 20

71-376 **WIRE BENT AT RIGHT ANGLES** after Hall, No. **73** 02

71-360 **MOUNTED CARDBOARD SCREEN** 28

71-362 **OPAQUE SCREEN WITH CROSSED OPALESCENT SQUARE OPENING,** after Fuller and Brownlee (Experiment **40**) 30

71-364 **BLACK AND WHITE OPAQUE SCREEN WITH SQUARE OPENING,** after Fuller and Brownlee (Experiment **48**) 20

71-366 **BUNSEN SCREEN,** simple form for use in Holders Nos. **71-356** and **71-368** 10

71-368 **SCREEN HOLDER** for use on meter stick, after Turner and Hersey (Experiment **L011**) 50

71-370 **CANDLE HOLDER FOR ONE CANDLE,** for use on meter stick, after Turner and Hersey (Experiment **L011**) 30

71-372 ——, for **FOUR CANDLES** for use on meter stick, after Turner and Hersey (Experiment **L011**) . .40

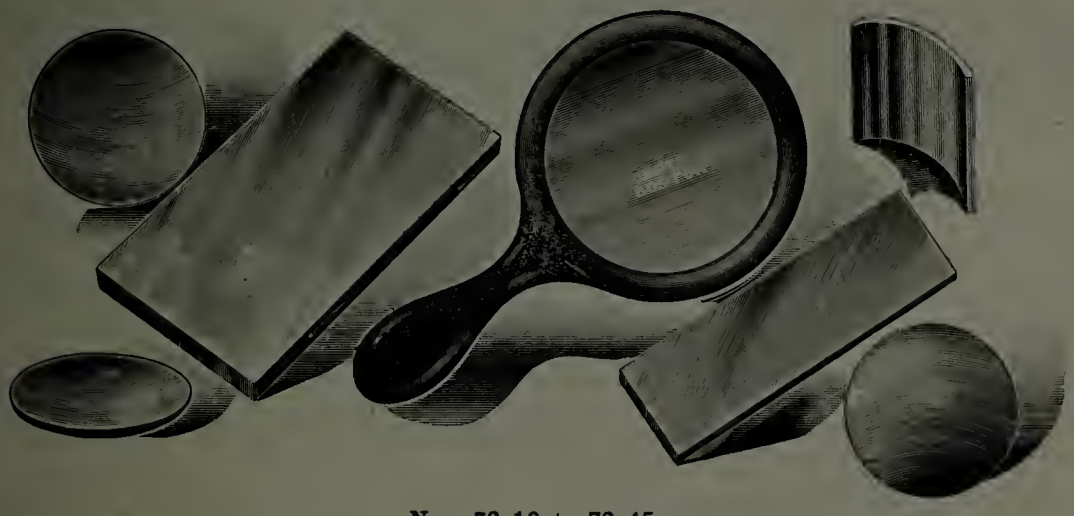
71-380 **CARDBOARD DIAPHRAGM WITH ONE CENTIMETER OPENING,** after Turner and Hersey (Experiments **L101** and **L105**) 06

71-400 **CULLER'S PRINCIPLE FOCUS BOX,** after Culler (Experiment **XXXV**) 1.25

71-500 **MOUNTED CONVEX LENS AND WIRE SCREEN,** after Millikan, Gale and Bishop (Experiment **46**) 75

REFLECTION OF LIGHT

MIRRORS



Nos. 72–10 to 72–45

72–10 PLANE GLASS MIRROR for experiments in reflection of light. Best German glass, 6 inches long by 2 inches wide . . . . . Each **$0.08**

72–10a SPRING BRASS CLIPS for holding mirror to a block . . . . . Pair **.30**

72–10b VERTICAL INDEX BLOCK with white face, after Hall, No. **66** . . . . . **.15**

72–12 PLANE MIRROR, similar to No. **72–10,** but 6 inches × 4 inches . . . . . Each **.15**

72–15 BLACKENED PLATE OF GLASS, after Millikan, Gale and Bishop (Experiment **42**) . . . . . **.06**

72–20 CONCAVE AND CONVEX CYLINDRICAL MIRROR. This is a cylindrical brass mirror, carefully burnished on both sides and heavily nickel-plated. One side is concave and the other convex. Each **.50**

72–20a BRASS PLATE with four Projecting Needles, after Hall, No. **67a** . . . . . **.75**

72–20b BRASS PLATE with seven Projecting Needles, after Hall, No. **67b** **1.25**

72–25 CONCAVE AND CONVEX SPHERICAL MIRROR. This is a spherical mirror of brass, 3 inches in diameter, 6-inch focus. It is carefully burnished and nickel-plated on each side, one side convex and the other concave . . . . . **.50**

72–35 CONVEX MIRROR. This is a carefully silvered glass mirror with a protective coating. It is 3 inches in diameter, with a focus of 6 inches **1.25**

72–37 CONCAVE MIRROR. This is a carefully silvered glass mirror with a protective coating. It is 3 inches in diameter, with a focus of 6 inches **1.25**

72–45 MOUNTED CONCAVE AND CONVEX MIRROR. This instrument consists of two mirrors, one concave, the other convex, mounted in a circular wooden frame, with handle; diameter 5 inches . . **2.25**

No. 72-70

No. 72-60

No. 22-145

72-60 IMPROVED INCIDENCE AND REFLECTION APPARATUS for determining the law of reflection of light.

In use, one arm is set at any desired position. Sighting across the second, this arm is moved until the image of the first and the etched line of the mirror and the sighting edge of the second are in the same straight line. If the positions of these index arms are noted on the graduated arc it will be found that the Angle of Incidence is equal to the Angle of Reflection **$2.25**

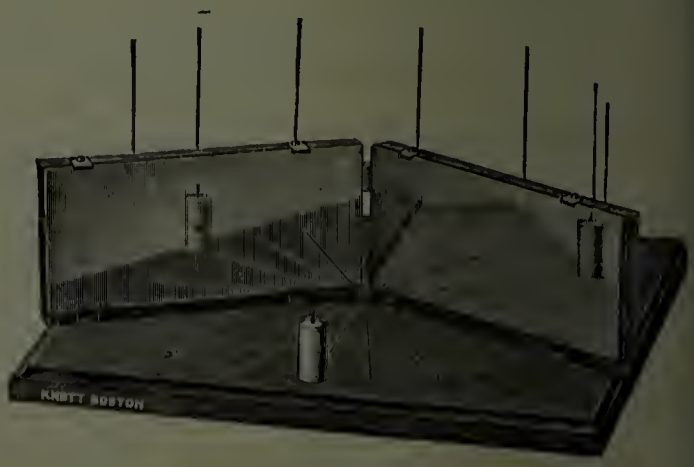
72-70 GAGE'S REFLECTION APPARATUS for demonstrating the law of reflection of light.

By glancing in the mirror through the hole marked "O" an image only of the hole is seen. If the source of light is held before any of the other holes the image in the mirror can be seen only through the hole equally distant on the other side of the normal to the mirror **2.45**

22-145 INCIDENCE AND REFLECTION APPARATUS. The apparatus illustrated consists of an attachment for our Universal Stand No. **22-130.**

In use, the candle is placed in the holder and trimmed so that its flame may be on the plane with the sight hole. It is then lighted. The arm for carrying the sight hole is moved along until the rays of the candle flame are seen through the sight hole. By a glance at the sector line it will be found that this Line of Reflection makes the same angle with the normal to mirror as the Line of Incidence makes with this perpendicular, thus proving that the Angle of Reflection is equal to the Angle of Incidence **6.65**

No. 72-90



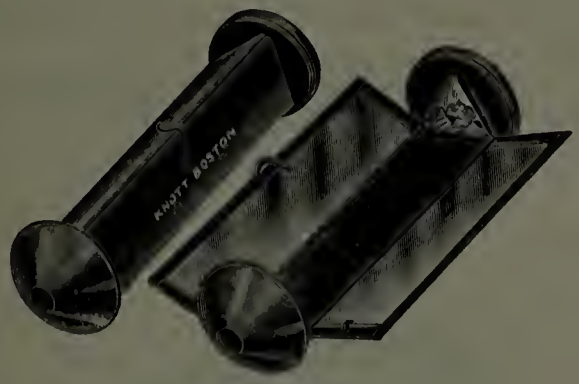
No. 72-95

72-90 MULTIPLE REFLECTION APPARATUS for illustrating the phenomenon of multiple reflection.

This apparatus consists of a handsomely finished metal casting on which are degree lines denoting every ten degrees. Two mirrors, mounted on appropriate metal frames and hinged at the center of the circle, are movable within 180°. In this casting a candle holder is provided for holding the candle in the best possible position. A further advantage of this model is that the mirrors may be unhinged from the center and mounted parallel, thus showing the infinite number of images that may be formed in mirrors mounted parallel to each other **$6.50**

72-95 PLACED IMAGE MULTIPLE IMAGE APPARATUS, after Hall and Bergen's "A Text-Book of Physics," page 158.

In use the mirrors are placed upon the board with the reflecting surfaces making an angle of 90°, — in the position as illustrated. The lighted candle should be of such height that its flame will not be above the upper edge of the mirrors and should be exactly over the middle hole in front of the board. The positions of the images of the candle should now be noted and pegs placed into the holes behind the mirrors in such a position that, to an observer placed in front of the mirrors, the images in the mirrors and the pegs over the mirror will appear to coincide with the images. The experiment should be modified with the mirrors at angles of 60° and 30° also. **2.75**



No. 72-100

72-100 **KALEIDOSCOPE.** This apparatus is a design of our own and consists of 3 mirrors, each separately mounted in a metal frame and combined to form a case with mirrors at angles of 60°. One end is closed by a disc of ground glass, the other is provided with a cap with an aperture. Fragments of colored glass are placed at one end between the ground glass discs and the second clear glass disc. The objects and their images when viewed through the aperture present themselves in an endless variety of symmetrical forms as the Kaleidoscope tube is turned **$2.75**

72-105 **STUDENTS' KALEIDOSCOPE,** similar in design to above, but of simpler construction . . . . . **.48**

No. 72-125

No. 72-140

72-125 **LUMINOUS CASCADE,** used with a strong source of light and a condenser for showing total reflection by means of a jet of water. The cylindrical vessel illustrated is placed in front of the source of light in such a way that the glass disc is parallel to, and about 2 centimeters from, the condenser. Water as pure as possible is poured into the vessel and allowed to issue from the jet orifice. The stream of water is then seen to be illuminated for a considerable distance.

A pleasing modification of this experiment is to insert colored glass plates between the condenser and the window of the vessel **$5.40**

72-140 **OPTICAL DISC TOTAL REFLECTION APPARATUS** for showing total reflection in glass rods; also illustrating the Luminous Cascade.

The apparatus consists of a dull black board designed for attachment to the face of the Optical Disc as illustrated. On the board are mounted three bent glass rods, one of which is smooth, the other two covered with small chinks of glass. The ends of these rods pass through a diaphragm on which the light falls. Light, therefore, enters these rods through the ends. The effect is readily noticeable. The smooth rod remains dark, while the ones with small chinks glisten with bright light. The light, however, in the smooth rod, being conveyed further by total reflection, passes out in nearly full strength upon a screen mounted to the face of the board; on the other hand, the spot of light received on the screen from the rod with small chinks is noticeably fainter, inasmuch as the light in the rod has partially passed out through the chinks in the walls causing the glistening bright light.

This experiment is extremely effective when colored light is used. It has distinct advantages over the Luminous Cascade No. **72-125,** in that the observations of the experimenter are not disturbed by the necessity of catching the water and refilling the apparatus.

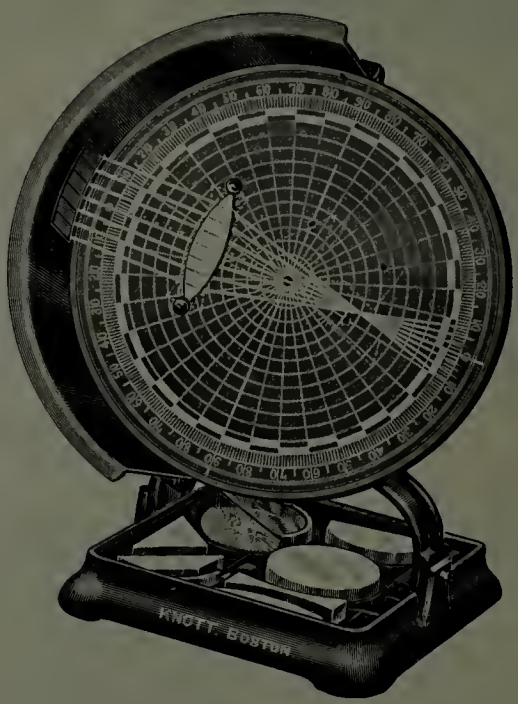
Complete ready for attachment to face of Optical Disc . . . . . Duty Free . . .

KOLBE-HARCOURT SELF-CONTAINED

UNIVERSAL INCLINATION OPTICAL DISC

No. 73–10

Rear View
Wing Nut Loosened Permits of Tilting



Front View
Dial Tilted

The Optical Disc is doubtless the most satisfactory outfit ever designed for illustrating in simple and concise form the fundamental laws of optics.

Rays of sunlight, direct or reflected, will show as white paths of light across the face of the dial. When a prism, lens or mirror is placed in these paths, the light is refracted or reflected as may be noticed from the paths traced by the rays of light. Results are clear and positive. They can be viewed by the whole class even across a large lecture room.

A great many instructive experiments may be demonstrated and the phenomena studied by the entire class. In a special pamphlet which we will send on application, we have suggested a few of these that can be considered as fundamental. Experience will suggest many others. This instrument has been designed particularly for use in a lecture hall. Our new model, the Kolbe-Harcourt Optical Disc, retains the same optical perfection of our original design, yet the following mechanical characteristics greatly enhance its value and will readily serve to distinguish our instrument.

FEATURES

1. The apparatus is self-contained in that prisms, lenses, mirrors, etc., are provided for on the instrument itself.

2. Any conceivable angle of tilt for the dial.

3. Shade and dial are independently mounted on separate axes and may be rotated independently of each other.

4. Greater stability secured by our rectangular metal base with forked upright support.

5. The recessed portion with individual pockets for each optical part enables one to definitely locate any of the parts when operating in a dark room.

6. The instrument is scientific in structure and appearance.

7. A 13-inch dial with improved graduations distinctly and clearly brought out by careful differentiation of lines and figures.

PRICE, $16.50

A ray reflected from a plane mirror. Angle of incidence equal to angle of reflection.

Reflection from a plane mirror. Incident parallel rays are reflected parallel.

Reflection from a convex mirror. Showing divergence of rays.

Reflection from a concave mirror. Showing convergence of rays.

One-half of ray refracted. Showing angle of refraction.

Angle of deviation — minimum angle of deviation. Showing an incident ray emerging parallel, since surfaces are parallel.

Total reflection. Showing rays totally reflected at the hypothenuse and reversed upon emerging.

Ray partly reflected, partly refracted. Showing angle of incidence and refraction.

Ray totally reflected. By turning disc, critical angle may be determined.

Refraction through double convex lens. Showing convergence of rays.

Refraction through double concave lens. Showing divergence of rays.

Theory of the rainbow. Showing the "Primary bow."

Send for Special Pamphlet describing experiments suggested above in diagram.

73–50 DIVERGING RAY ATTACHMENT. This attachment consists of a system of concavo-cylindrical lenses mounted in a frame and adjustably supported in a clamp on a tripod stand.

In use the concavo-cylindrical surfaces are directed toward the light source. Each individual lens sends out a bundle of diverging rays and one ray from each lens will pass through the slit in the screen, forming a system of diverging rays which appear to come from the slit as a source and cross the face of the dial.

Many of the experiments described under the Kolbe-Harcourt Optical Disc should be repeated, using the diverging rays. Better educational results are secured if diverging rays through but two slits are used and the light through one of these slits be made to pass through a colored strip of glass placed under the clips provided on the screen for the purpose. This arrangement enables one to definitely locate the different foci and to trace the formation of real and virtual images.

Diverging Ray Attachment complete as illustrated **$5.50**

No. 73–50

73–75 REFRACTION TANK for study of refractions in water and for determining the index of refraction of any liquid inactive upon the metal.

No. 73–75

This attachment, which fastens to the center of the Kolbe Optical Disc, consists of a circular tank with glass front. This glass covers slightly more than one-half circle so that the water level may be used at the 90-90 mark. That results may be quantitatively made the whole-circle back is graduated.

In use the tank is attached to the face of the disc and filled to the 90-90 degree line with the liquid to be studied. A ray of light is then allowed to strike the surface of the liquid. This ray traces a path through the liquid which may be read through it. From the Angle of Incidence read from the face of the disc and Angle of Refraction read from the graduated circular back the Index of Refraction of the Liquid may be determined.

Refraction Tank ready for use on disc **$3.35**

No. 73–80

73–80 POLARIZED LIGHT ATTACHMENT. This device is used in studying the fundamental phenomena of Polarized Light, — uniform reflection of ordinary unpolarized light, polarization by reflection, polarization by multiple refractions, chromatic polarization and many other important phenomena that readily suggest themselves when the instrument is in use.

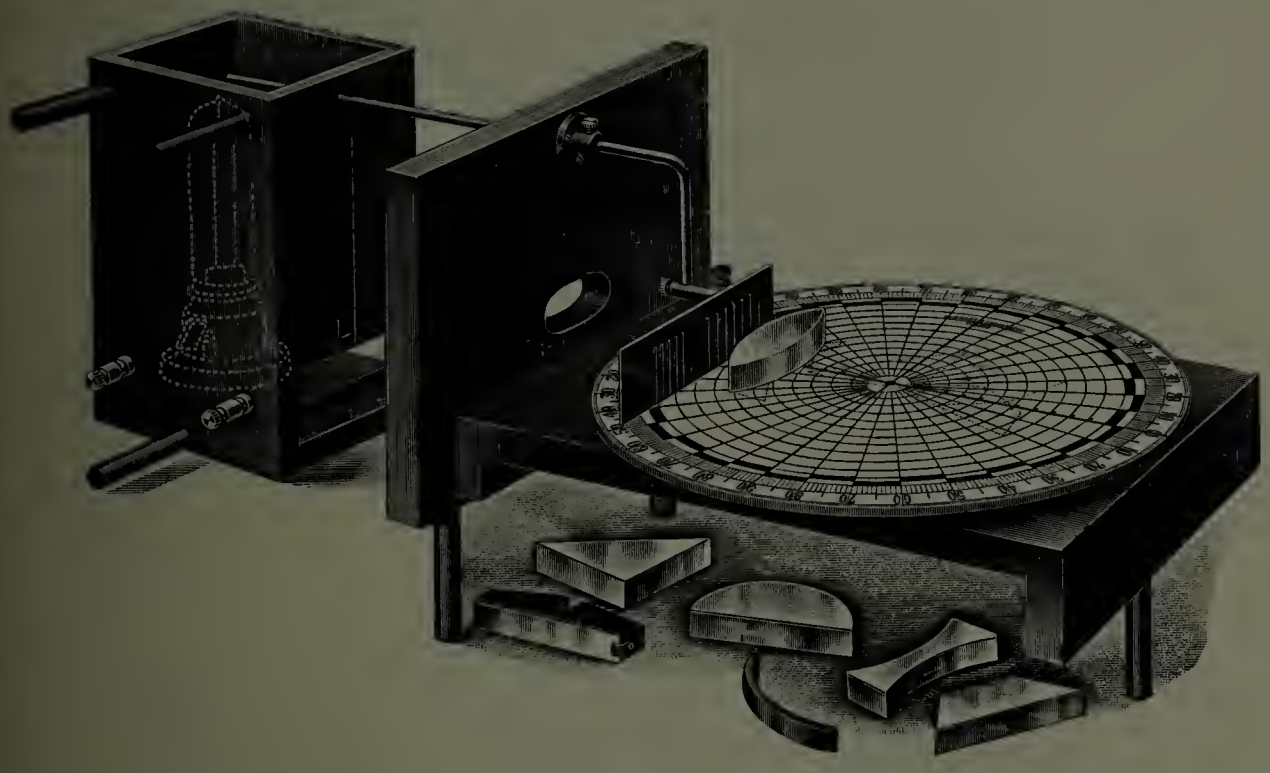
All parts of this attachment are fastened to a rectangular metal plate which, in use, is held to the face of the disc by means of thumb screws. At one end of the rectangular metal plate will be found the holder for the polarizers, — the single plate of glass and the bundle of glass plates; at the other end is the analyzer, — a heavy black glass plate held at proper inclination and position in a special holder which permits of rotary motion. To this same holder is attached the projection screen in rotary adjustment. Between analyzer and polarizer is situated the stage provided with a simple holder for specimens for study under polarized light.

The attachment is fastened to the dial of the Kolbe-Harcourt Optical Disc in the same manner as are the various optical parts in previous experiments, short thumb screws provided with the attachment being used for this purpose. Use the full beam of light through the rectangular opening in the shade **$8.25**

73–90 THE COWEN N. and F. APPARATUS for use on Optical Disc to illustrate near and far sightedness **1.00**

No. 73-101

HARCOURT IMPROVED STUDENTS' OPTICAL DISC



The Kolbe-Harcourt Optical Disc previously illustrated and described, was designed and especially constructed with universal adjustment for use in lecture work. No. **73–101,** above illustrated, is a simplified form utilizing the same optical parts but for use in horizontal position only. The design is particularly adapted to experiments described in our National Physics Direction Sheets Nos. **L110** to **L118,** a full list of these experiments being supplied with each outfit.

Illustrated above and in our National Physics Direction Sheets Nos. **L110** to **L118** will be noted our Incandescent Lamp and Shield. This apparatus has been found a most convenient and satisfactory source of light.

Direction sheets are furnished and the Students' Optical Disc is particularly adapted to following experiments:—

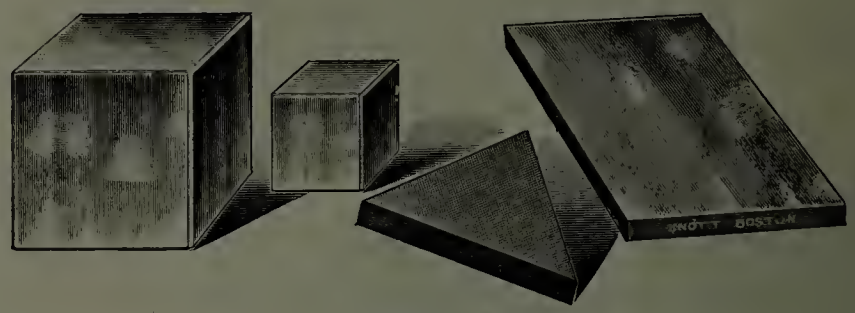
1. With Plane Mirror, — Law of Reflection; Parallel Rays; Diverging Rays; Image of a Point.
2. With Concave Mirror, — Normal Incidence; Principal Focus; Parallel Beam by Reflection; Spherical Aberration; Caustic Curve.
3. With Convex Mirror, — Parallel Rays; Principal Focus; Virtual Image of a Point.
4. With Trapezoidal Glass Plate, — Lateral Aberration; Path of Ray through Prism; Minimum Deviation; Disperson.
5. With 45 Degree Right Prism, — Single and Double Total Internal Reflection.
6. With Convex Lens — Ray through Optical Center; Principal Focus; Spherical Aberration; Conjugate Foci.
7. With Concave Lens, — Ray through Optical Center; Principal Focus.
8. With Semi-circular Glass Plate, — Ray passing between Glass and Air; Index of Refraction for Glass; Critical Angle; Total Internal Reflection.

HARCOURT IMPROVED STUDENTS' OPTICAL DISC without Optical Parts **$8.75**

73–102 **OPTICAL DISC GLASS PARTS,** complete as described under No. **73–101** **6.25**
NOTE. One set No. 73-102 will be found sufficient for four groups of pupils.

73–106 **SPECIAL 110-VOLT LIGHT BOX,** designed by C. Brooks Hersey of the Masten Park High School, Buffalo, New York, for general laboratory work **3.25**

REFRACTION OF LIGHT



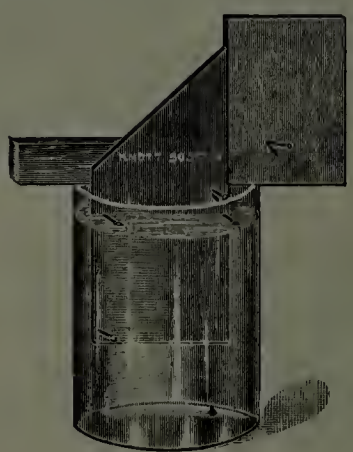
Nos. 74–50 to 74–62

74–50 **INDEX OF REFRACTION PLATE, GILLEY FORM,** for determining the index of refraction of glass. This is a standard glass index of refraction plate, universally described in text-books and manuals. Dimensions, 3 × 4 inches. Polished edges $0.27

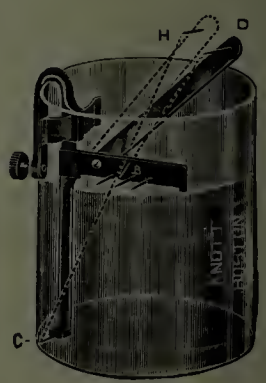
74–55 **EQUILATERAL PRISM,** after Millikan and Gale's "A Laboratory Course in Physics" (Experiment **43**). This is a triangular prism of heavy glass plate, 75-millimeter edge. Edges polished 45

74–60 **GLASS CUBE** for the determination of the index of refraction of glass. Polished faces, 30-millimeter edge 55

74–62 ——, same as above, but 50-millimeter edge 95



No. 74–75



No. 74–85

74–75 **GILLEY INDEX OF REFRACTION OF WATER BOARD** for determining the index of refraction of water.

This apparatus consists of a thin board attached to a cross-head. The cross-head is of the size and length to hold the board perpendicular in the jar of water. The line of sight as well as the water level is determined by means of pins. Without Jar $0.75

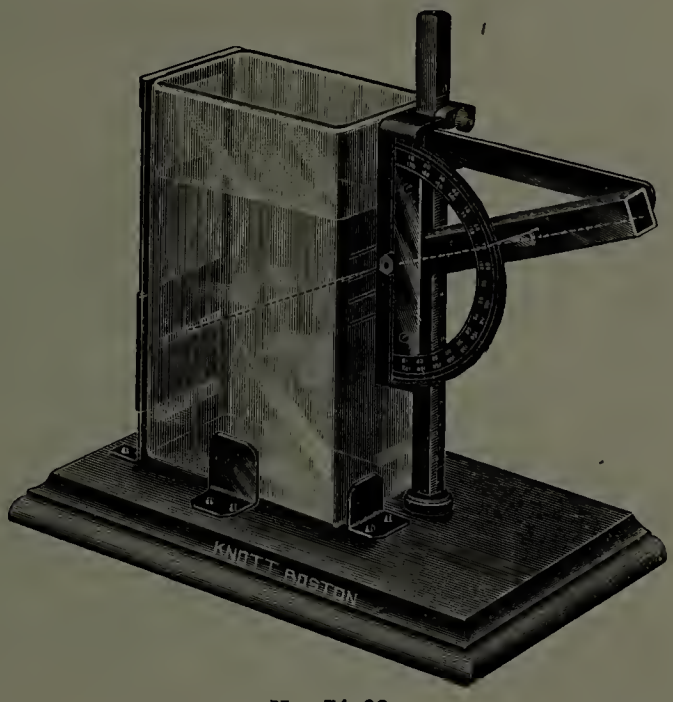
31–265c **GLASS JAR** for above, 6 × 8 inches 40

74–81 **BRASS PARTITION** with attached clamps according to Hall and Bergen 20

74–82 **BRASS CLAMPS** with index points according to Hall and Bergen . . . . . Each .20

74–85 **ADJUSTABLE SIGHTING ARM INDEX OF REFRACTION OF WATER APPARATUS,** a greatly improved design according to Culler's "Laboratory Manual of Physics" (Experiment **XXXIV**). Can be clamped on any jar, square or round, — an important feature in that the angle of refraction may be accurately transferred to the note-book page by removing the apparatus from jar and pressing needle points down into the blank sheet. Without jar 1.40

No. 74–90



No. 74–92

74–90 PRATT INSTITUTE INDEX OF REFRACTION APPARATUS for determination of Index of Refraction of Water.

This instrument consists of a metal casting holding a metal strip with spring grip in each of the four slots. The lower ends of the two inner strips are intended to give the line of water, the strip at right of the illustration to give the angle of incidence. In use the lower end of this strip touches the water line, the line of sight starting over the beveled top. The fourth strip is adjusted to give the line of refraction. Beginning with the strip at the left, then, the line of sight is over the top of the first across the bottom of the second to the bottom of the fourth. When these points are obtained the instrument is taken from the jar and the straight edges placed on a sheet of paper and the line of sight drawn. Index may be determined by ordinary geometrical method or the sines of the angles obtained may be secured from any logarithmic table.

The simplicity of this instrument will appeal to all. The facility of use, scientific observation of details and appearance will doubtless be noted. Without jar **$2.10**

74–92 UNIVERSAL DIRECT READING INDEX OF REFRACTION APPARATUS for determining the index of refraction of any colorless liquid, — acid or alkali.

This instrument consists of a base on which is mounted a graduated rod. On this rod is fitted a frame, free to move up and down the rod, and which may be clamped wherever desired by means of set screws. To this frame are attached an arc and a side tube with cross-wire. This side tube is swiveled at the center of the arc. A clear glass jar is held to the base, close up to the frame, by means of spring clips fastened to the base. The side nearest the arc has engraved on its face four lines. The opposite side is provided with a metal frame on which slides a screen with movable slit. The line of sight, therefore, is from the cross-wire inside of the tube through the tube through one of the lines engraved on the jar to the slit on the opposite side of the jar.

The apparatus is accurately constructed, graduations clear and distinct, handsomely finished.

Three methods of determining the index of refraction of a liquid are possible:

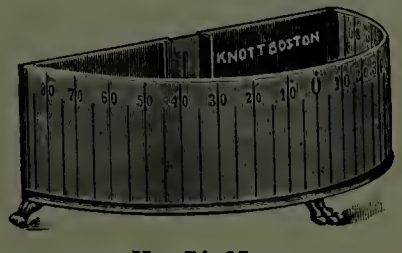
1. Index of Refraction may be read from the arc, and the sines of the angles from any logarithm table.
2. Length of the sines may be read directly by means of the sliding index on the graduated rod.
3. The index may be determined by the usual geometrical construction of the angles to the mensuration of the sines.

Apparatus complete as illustrated, furnished with simple laboratory directions **4.30**

74–95 REFRACTION TANK for experiments on refraction at plane surfaces.

This tank consists of a semi-circular vessel of glass, one side of which is curved, and the other side opaque except for the slit through which the light may enter the tank. The reading of the path of the light may be made when the tank is empty.

This is an interesting and instructive experiment and the apparatus is sufficient in size for use in lecture experiments **$8.00**



No. 74–95

DEMONSTRATION LENSES

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No. 74–107

74–107 **DEMONSTRATION LENSES.** A set of 10 lenses, each 3 inches in diameter. These lenses include one each of the following types:

Double-convex, double-concave — **Cylindrical-convex, cylindrical-concave**
Plano-convex, plano-concave — **Sphero-cylindrical, sphero-prismatic**
Periscopic convex, periscopic concave

The complete set of 10 lenses, 3 inches in diameter **$12.50**

74–110 **DEMONSTRATION LENSES.** Set including one each of the following lenses:

Double-convex, double-concave — **Plano-convex, plano-concave**
Periscopic convex, periscopic concave

Set of 6 lenses, 2 inches in diameter, in box **2.50**

74–112 ——, set of 6 lenses, same as above, 1½ inches in diameter, enclosed in cardboard box **1.25**

LABORATORY LENSES

DOUBLE CONVEX LENSES, highest quality, carefully polished, ground edges.

Number	74–118	74–120	74–121	74–122	74–122a	74–123	74–124	74–125	74–126
Diameter	1½	1½	1½	2	2	2½	3	4	4 inches
Focus	2	4	6	5	20	6	7	10	16 inches
Each	$0.50	.27	.24	.42	.35	.60	.75	.95	1.30

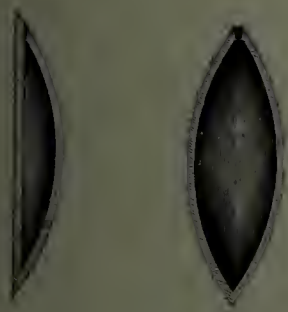
DOUBLE CONCAVE LENSES, highest quality, carefully polished, ground edges.

Number	74–150	74–151	74–152	74–153
Diameter	1½	1½	2	3 inches
Focus	6	8	8	6 inches
Each	.22	.22	.50	.90

CONDENSING LENSES, plano-convex, highest quality, carefully polished, ground edges.

Number	74–170	74–171	74–172	74–173
Diameter	4½	4½	5	6 inches
Focus	6½	10	8	10 inches
Each	$1.10	1.10	1.70	6.00

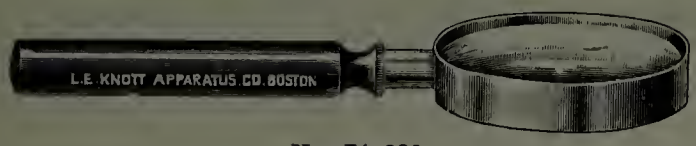
MISCELLANEOUS LENSES



No. 74–180 No. 74–182

No. 74–210

No. 74–190



No. 74–230

Nos. 74–220 to 74–225

74–180 **WATER LENS.** This is a hollow plano-convex vessel, with opening for introduction of water. Diameter 80 millimeters **$3.90**

74–182 **WATER LENS.** This is a hollow double-convex vessel, with opening for introduction of water. Diameter 80 millimeters **3.90**

74–190 **DEMONSTRATION ACHROMATIC LENS.** This lens, in reality, consists of 2 lenses, a concave and a convex lens, each 1½ inches in diameter, accurately ground to fit each other. Achromatism positive . . . . . Per Pair **.75**

74–192 **ACHROMATIC LENS,** consisting of two lenses, a diverging concavo-convex flint glass lens and a double-convex crown glass lens, accurately ground and polished, and perfectly fitted to each other. Diameter 2 inches, focus 8 inches **4.80**

74–210 **MOUNTED CONDENSING LENS.** This is a condensing lens 5-inch diameter, 8-inch focus, mounted on the Hall Universal Stand, adjustable to height and plane. The stand is of brass and of a design constructed to facilitate in obtaining all positions desired for the lens in laboratory practice. Brass parts are polished and lacquered; base is finished in black japan.
Complete as illustrated **5.55**

74–215 **MOUNTED DOUBLE-CONVEX LENS.** This is a double-convex lens, 4-inch diameter, 14-inch focus, mounted in a universally adjustable stand described under No. **74–210** **5.25**

74–220 **MOUNTED HOLLOW PLANO-CONVEX LENS.** This is an 80 mm. plano-convex water lens, mounted as illustrated **5.25**

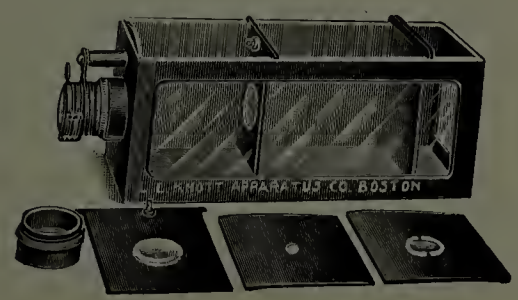
74–225 **MOUNTED HOLLOW DOUBLE-CONVEX LENS.** This is an 80 mm. double-convex water lens, mounted as illustrated above **5.25**

74–230 **READING LENS.** This is a double-convex lens, mounted in a metal frame and provided with handle. Diameter of lens 3 inches **1.00**

74–231 **LONG FOCUS LENS** with handle . . . . . **.60**

74–235 **POCKET MAGNIFIER (LINEN TESTER).** This is a small double-convex lens, short focus, ½-inch aperture. It is mounted in a brass piece that may be folded into small compass . . . . **.44**

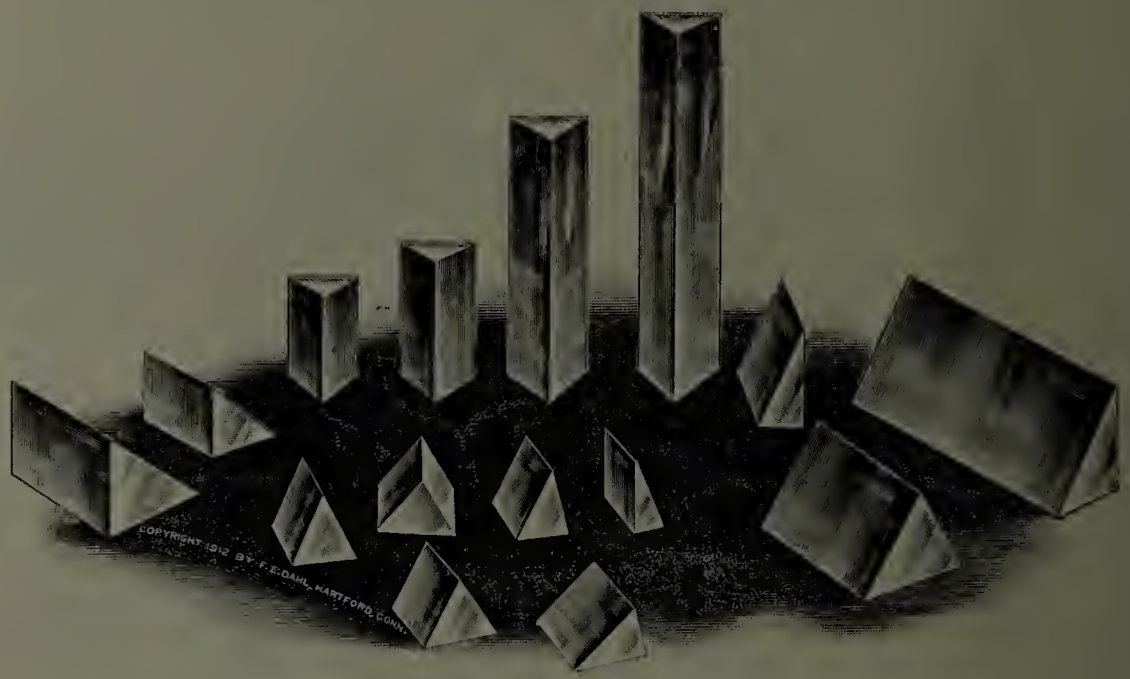
74–240 **KUEHNE'S EYE MODEL** for the demonstration and study of the optical construction of the eye, its normal and abnormal condition and the necessary corrections.
The apparatus consists of a water-tight rectangular box with various accessories, such as the two corneas, one of which is fitted with a cylindrical lens, two eye lenses of different foci, three diaphragms, retina and six glasses to be used in front for correcting errors.
Apparatus complete as above described, including full instructions for use **$28.00**



No. 74–240

74–247 **MODEL OF HUMAN EYE** of plaster of paris. Dissectible **6.50**

LABORATORY PRISMS



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Nos.

74–295 74–297 74–280 74–282

74–305 74–315 74–285

74–307 74–275 74–287

74–275 **STUDENTS' ODD ANGLE GLASS PRISMS** for general laboratory use, particularly for determining the index of refraction.

The tendency of pupils to copy results has led to the demand for prisms with odd angles. This set is one that has found favor in the laboratories of Cornell University and we have no hesitancy in recommending its use in any laboratory. The set consists of six prisms about 1 inch high and 1 inch face, with the following angles: first prism, 55°, 65°, and 60°; second prism, 48°, 69°, and 63°; third prism, 54°, 67°, and 59°; fourth prism, 42°, 74°, and 64°; fifth prism, 43°, 74°, and 63°; sixth prism, 23°, 90°, and 67°.

Set of six prisms in neat cardboard box **$9.50**

74–280 **EQUILATERAL PRISM,** flint glass, square ends, 30-millimeter face, 4 inches long . . . . . **.60**

74–282 **EQUILATERAL PRISM,** flint glass, square ends, 30-millimeter face, 6 inches long . . . . . **.75**

74–285 **EQUILATERAL PRISM,** flint glass, square ends, 50-millimeter face, optically true surface, 4 inches long . . . . . Duty Free **14.25**

74–287 **EQUILATERAL PRISM,** flint glass, square ends, 40-millimeter face, about 2 inches long, surfaces optically true . . . . . Duty Free **10.50**

74–295 **EQUILATERAL PRISM,** crown glass, square ends, 25-millimeter face, 1½ inches long . . . . . **.36**

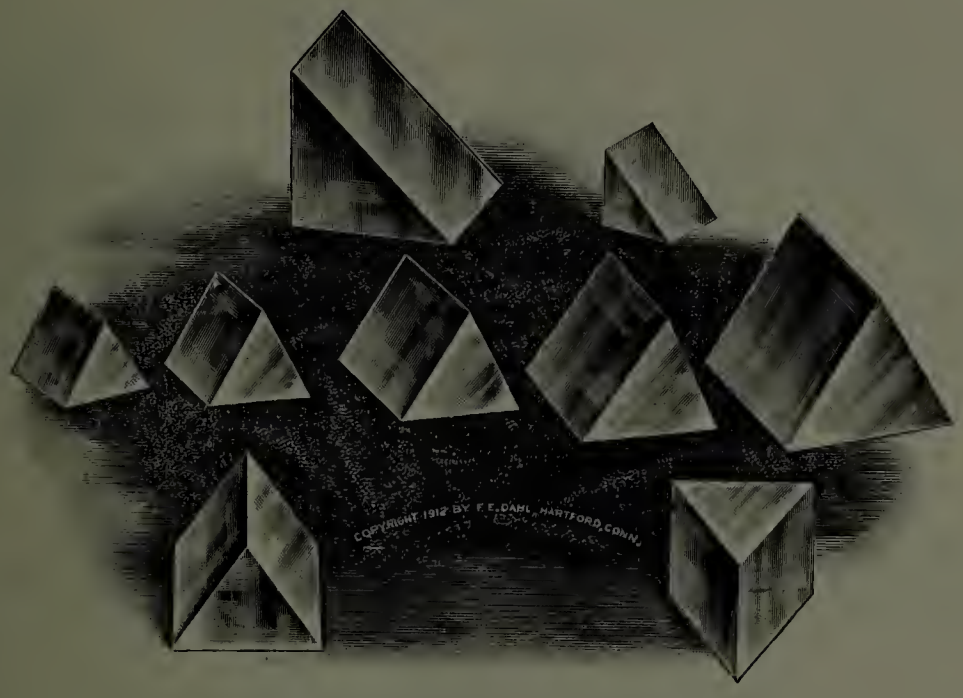
74–297 **EQUILATERAL PRISM,** crown glass, square ends, 25-millimeter face, 2 inches long . . . . . **.48**

74–305 **RIGHT ANGLE PRISM** for total reflection, angles of 45 and 90°, sides 25 by 25 millimeters, length 1½ inches . . . . . **.60**

74–307 **RIGHT ANGLE PRISM** for total reflection, angles of 45 and 90°, sides 38 by 38 millimeters, length 2 inches . . . . . **.75**

74–315 **FLINT GLASS PRISM,** refracting angle of 20°, sides 41 millimeters, length 1½ inches . . . . . **.50**

SPECTROSCOPIC PRISMS



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No. 74–367 No. 74–365
Nos. 74–350 a-e, to Nos. 74–360 a-e
Nos. 74–390 a-c Nos. 74–400 a-c

74–350 FLINT GLASS EQUILATERAL SPECTRAL PRISMS, optically true surfaces, square ends.
Refractive Index for D = 1.602; Dispersion C–F = 1° 58′; Minimum for M/D = 55° 20′

	a	b	c	d	e
Side	25	30	35	40	50 millimeters
Each, Duty Free	**$4.75**	**5.25**	**6.25**	**7.40**	**9.75**
Each from Stock	**6.25**				

74–360 CROWN GLASS EQUILATERAL SPECTRAL PRISMS, optically true surfaces, square ends.
Refractive Index for D = 1.517; Dispersion C–F = 41′; Minimum for M/D = 50° 24′

	a	b	c	d	e
Side	25	30	35	40	50 millimeters
Each, Duty Free	**$4.75**	**5.25**	**6.25**	**7.40**	**9.75**
Each from Stock	**6.25**				

74–365 CROWN GLASS SPECTRAL PRISM, angles of 45 and 90 degrees, cathetus 25 millimeters.
Duty Free **$5.25**

74–367 CROWN GLASS SPECTRAL PRISM, angles of 45 and 90 degrees, cathetus 50 millimeters.
Duty Free **9.40**

74–370 RUTHERFORD'S COMPOUND ACHROMATIC PRISMS, consisting of a flint glass prism luted between two crown glass prisms.

	a	b	c	d	e
Side	20	30	40	50	60 millimeters
Each, Duty Free	**$9.75**	**14.50**	**23.25**	**38.50**	**49.75**

74–380 AMICI'S DIRECT VISION PRISMS, consisting of three prisms so arranged as to give direct vision.

	a	b	c	d
Cross-cut	10	20	30	40 millimeters
Each, Duty Free	**$4.75**	**12.25**	**18.50**	**39.75**

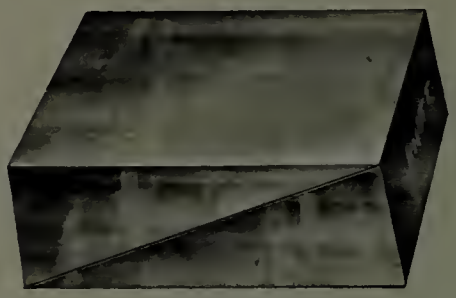
74–390 EQUILATERAL QUARTZ PRISMS, with the refracting edge perpendicular to the optical axis.

	a	b	c
Side	25	35	45 millimeters
Each, Duty Free	**$8.50**	**14.25**	**22.00**

74–400 EQUILATERAL QUARTZ PRISMS, having the refracting edge parallel to the optical axis

	a	b	c
Side	25	35	45 millimeters
Each, Duty Free	**$8.50**	**14.25**	**22.00**

MISCELLANEOUS PRISMS



No. 74–410

No. 74–425

74–410 **ACHROMATIC PRISMS,** faces polished optically true and carefully fitted.

	a	b	c
Aperture	25	35	50 millimeters
Each, Duty Free . . .	$5.75	7.40	9.80

74–420 **WEINHOLD'S DEMONSTRATION PRISMS** for explaining dispersion and achromatism without deviation of the mean ray.
Consists of three prisms, two of crown and one of flint glass, ground and polished optically true.
Set of three, without mounting of any kind . . . . . Duty Free **$9.75**

74–425 **POLYPRISM** for showing that the angle of deviation increases with the refractive index.
Each prism consists of four glass parts which are unequally refringent, luted to form a prism. Length of side, 35 millimeters . . . . . Duty Free **9.25**

No. 74–430

No. 74–432

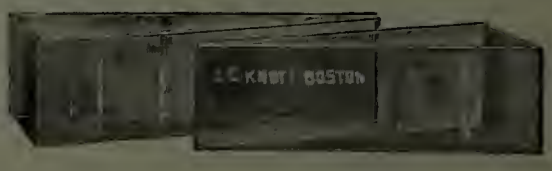
Nos. 74–434 to 74–435

74–430 **IMPROVED CAST HOLLOW PRISM.** The design illustrated above pictures our new model hollow prism, indestructibly constructed of cast metal with openings in two sides closed in an ingenious manner by optical plate glass. This prism will be found adequate for most laboratory work, and results are entirely satisfactory.
It is finished with a durable dull black coating **$3.75**

74–432 **OPTICAL GLASS CEMENTED FACE HOLLOW GLASS PRISM,** two faces cemented and polished, the third face blackened, ground glass stopper, height 65 millimeters, face 32 millimeters . . . **5.50**

74–434 **HOLLOW GLASS PRISM,** equiangular, of best ground and polished crystal plate glass, with ground glass stopper, partition cemented in the middle for two liquids. Mounted on wooden foot, 120 millimeters high by 80 millimeters face . . . . . Duty Free **7.50**

74–435 ——, same as above, but 100 millimeters by 60 millimeters wide . . . . . Duty Free **6.25**

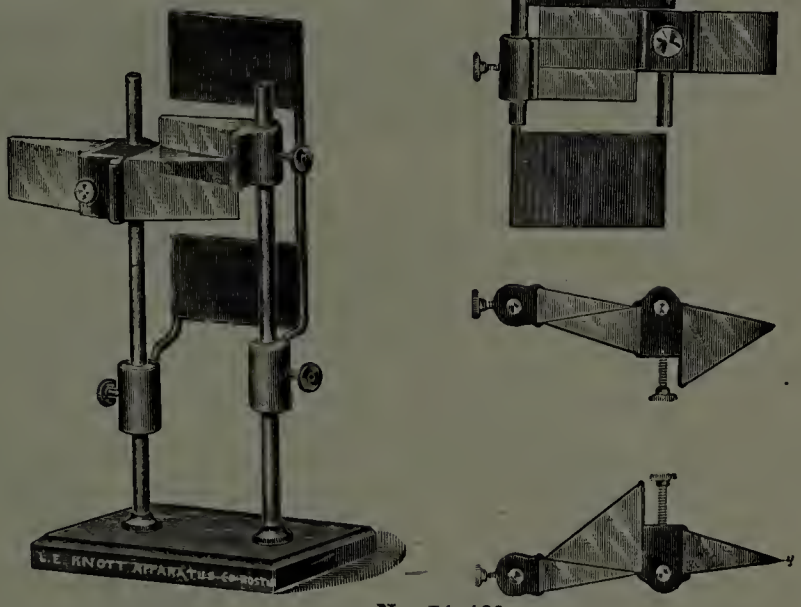


No. 74–438

74–438 **WEDGE-SHAPED TROUGHS,** a pair of wedge-shaped troughs each 6 inches long by 2 inches wide, refractive angles of 20° . . . . . Duty Free **$5 50**

MISCELLANEOUS PRISMS

No. 74–450



No. 74–460

74–450 **MOUNTED EQUILATERAL PRISM.** This is a 4-inch equilateral prism, mounted on the Hall Universal Stand as illustrated. This stand can be raised and lowered to any desired height or inclined to any angle. It is handsomely finished and the base offers a substantial support **$5.75**

74–452 ——, similar to above, but prism 6 inches long **5.75**

74–455 **MOUNTED TOTAL REFLECTION PRISM,** consisting of a right angle prism, flint glass, angles of 45° and 90° mounted on stand as illustrated in No. **74–450** **5.75**

74–460 **WEINHOLD'S DEMONSTRATION PRISM** for explaining dispersion and achromatism without deviation of the mean ray.

This apparatus consists of a set of three prisms conveniently mounted for the greatest utility and ease of adjustment. The lower combination gives an achromatic arrangement, while the upper gives direct vision dispersion. For demonstration, best results are secured by arranging the prisms so that the field is divided into three portions, the center of which is due to the combination. (See illustration at right.)

Complete with three prisms, each separately mounted, with supporting stand . . . . Duty Free . . .

No. 74–480

74–470 **DIRECT VISION PRISM,** after the original specifications of the late Mr. Eaton of Brooklyn, N. Y., for projection of spectra on a screen.

This prism consists of a combination of two prisms, one of dense glass, the other a hollow prism which in use is filled with carbon bisulphide, the angles of each of which are very nicely calculated, giving a direct vision spectrum of large dispersion. At a distance of twenty feet from the screen, with a ¼-size objective, it is possible to secure a clear spectrum band 6 feet long by 2 feet wide.

Mounted on rod telescoping into neat tripod stand **$27.50**

74–480 **POLYPRISM,** illustrating the phenomena of multiple refraction.

This apparatus consists of a cylindrically shaped wooden frame, in one end of which is mounted a prism, the face of which is cut into a series of very small prisms. The other end is provided with an aperture, so that an object such as a line may be viewed.

Curious and interesting modifications of the shape of an object are noted. The apparatus is small, easily handled, and will be found of considerable qualitative value . . . . . **.22**

No. 74–470

OPTICAL INSTRUMENTS

TELESCOPES — SEXTANTS

No. 75–30

75–30 ACHROMATIC TELESCOPE, extra quality, morocco-covered body, polished brass slides, cap for object glass and sliding cover for eye lens. Length, closed, 5½ inches, three draws to 14 inches long, magnifying power 12 diameters **$3.25**

ASTRONOMICAL TELESCOPES

No. 75–80

Among the high-grade telescopes now presented to the public no instruments have become so widely or so deservedly popular as the line herewith listed. Due to improved methods of manufacture and the consequent diminishing of the manufacturing cost, a high-grade instrument, like an astronomical telescope, has ceased to be the mere instrument of a profession, and the prices have become so reasonable that it is possible for a school or college to number one among its equipment.

The instruments herewith listed are noted for their optical range and capacity. The mechanical features are unexcelled and all accessories are of the same high quality. The policy of the manufacturers has been to make of each telescope an instrument reliable in quality and moderate in price. Each instrument is furnished fully equipped for good work by day or night.

75–50 **PORTABLE ASTRONOMICAL TELESCOPE.** This instrument has been designed light in weight for use on a table or stand. It has the same high optical qualities as have all the models of this manufacturer. Body of telescope, sliding tube for eye-pieces, and tubular support for table tripod, are of polished brass. Feet of tripod are wrought steel, japanned. The instrument has detachable sun-glass, brass cap for protection of object glass, and rack and pinion focusing adjustment. Three eye-pieces are furnished: one terrestrial eye-piece, power 45, and two astronomical eye-pieces, powers 50 and 114. Diameter of object lens, 3 inches; length of tube when closed, about 39 inches, — when extended, about 59 inches.

Telescope enclosed with table tripod in neat wooden box . . . . . Duty Free . . .

75–55 ——, same as above, but provided with large hardwood tripod in addition to the table tripod above furnished. Enclosed in neat wooden box . . . . . Duty Free . . .

75–60 **ASTRONOMICAL TELESCOPE.** This instrument is somewhat more elaborate than the preceding and has a greater focal length. In addition, the tripod is especially designed for stability and strength and is furnished with a simple but effective cranking adjustment for increasing or decreasing the height of the telescope. It is made of finely finished mahogany. Its construction insures rigidity and affords special steadiness of the telscope.

Each instrument includes a sun-glass, and three eye-pieces, one terrestrial and two astronomical. The power of the terrestrial eye-piece is 54 and the powers of the astronomical eye-pieces are 60 and 120. The size of the object lens is 3 inches; the telescope body with cap is of polished brass; length of tube when closed, about 46 inches, — extended, about 63 inches.

The instrument is furnished in wooden box with handle, lock, and key . . . . . Duty Free . . .

75–65 ——, similar to above, except that the object lens is 3¼ inches in diameter and the telescope is somewhat larger in size. The magnifying power of the terrestrial eye-piece is 59. The powers of the astronomical eye-pieces are 65 and 130. Length of tube closed is about 48 inches, — extended, 68 inches.

In neat wooden box with handle, lock and key . . . . . Duty Free . . .

75–70 ——, same as above, but provided with a "finder." This telescope is provided with a sun-glass and five eye-pieces: two terrestrial, magnifying 49 and 59 respectively, and three astronomical eye-pieces, magnifying respectively 65, 88 and 146 times.

Enclosed in wooden box . . . . . Duty Free . . .

75–75 ——, same as above, except that object lens is 3¾ inches in diameter, and the instrument is furnished with two terrestrial eye-pieces, powers 55 and 66, and four astronomical eye-pieces, powers 74, 99, 147, and 221. Length of tube closed, about 53 inches, — extended, about 73 inches.

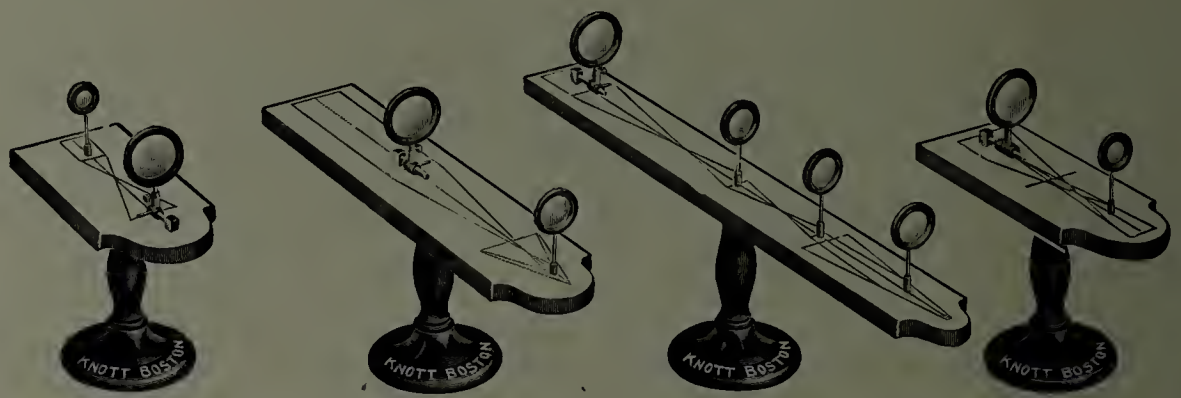
Enclosed in wooden box . . . . . Duty Free . . .

75–80 **ASTRONOMICAL TELESCOPE** (illustrated on preceding page). Uniting all the chief advantages of the types previously listed, this telescope is also provided with still another desirable feature. Each instrument is provided with two slow motions, making it possible for the astronomical observer to control the telescope with greater precision and with the least possible vibration. Tangent screws encased by rods that may be slowly turned by a very slight motion of the hand enable the observer to keep the object in field of view.

The telescope includes "finder," sun-glasses for the astronomical eye-pieces and five eye-pieces; two terrestrial eye-pieces, powers 49 and 59, and three astronomical, powers 65, 88 and 146. The size of the object lens is 3¼ inches. Telescope body, etc., are of polished brass, with brass cap to protect the eye lens. The tripod is especially strong and stable, and is constructed of mahogany, and, in addition to the slow motion adjustments already noted, has a special cranking mechanism for adjustment of the height. Length of tube when closed, about 48 inches, — extended, about 68 inches.

In wooden box with handle, lock and key . . . . . Duty Free . . .

75–85 ——, same as above, but larger in size. Object lens 3¾ inches in diameter. Six eye-pieces: two terrestrial eye-pieces, powers 55 and 66, and four astronomical, powers 74, 99, 147 and 221. Length of tube when closed, about 53 inches, — extended, about 73 inches . . . . . Duty Free . . .



No. 75–154 No. 75–151 No. 75–152 No. 75–150

These models consist of lenses mounted in holders placed appropriately for the best definition.

The holders are mounted on a cross-head attached to a neatly finished wood stand. The paths which the rays take are sketched on the flat face of the cross-head. These models will be found instructive and as the magnification and definition are excellent they will be found of great utility.

75–150 **GALILEO'S TELESCOPE MODEL,** comprising two lenses, the object glass, and a diverging or double concave eye-piece. This instrument illustrates the common Opera Glass, giving an erect image **$4.50**

75–151 **ASTRONOMICAL TELESCOPE MODEL,** consisting of two lenses, one the condensing eye-piece and the other the object glass. In comparison with No. **75–154,** Model of the Microscope, it will be seen that this astronomical telescope is analogous to the microscope, differing in the respect that, in the microscope the object being seen through the object glass the image formed must be on the principal focus and is, therefore, greatly magnified, so that both the object glass and the eye-piece magnify, while in the astronomical telescope the heavenly body being at a great distance the rays are parallel and the image formed on the principal focus of the object glass is much smaller than the object. There is, therefore, little magnification except that secured by the eye-piece, which usually is of short focal length.

The lines which represent the path of the rays bring this out very clearly in object models . . . **6.40**

75–152 **TERRESTRIAL TELESCOPE MODEL,** consisting of two condensing lenses placed between the object glass and the eye-piece. It will be noted that this telescope differs from the astronomical telescope in that it produces images in their right positions **7.15**

75–153 **TELESCOPE MODELS,** as listed above, showing the construction of the principal telescopes, set of three **18.00**

75–154 **MICROSCOPE MODEL,** consisting of two lenses, one the objective, the other the eye-piece **4.50**

75–155 **DEMONSTRATION MICROSCOPE,** after Millikan and Gale's "A Laboratory Course in Physics" (Experiment **45**), for determining the magnifying power of a microscope.

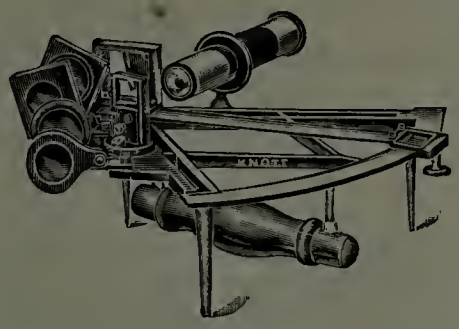
The apparatus consists of a brass tube, on either end of which are placed strips with apertures. Over one end is fastened a linen tester, No. **74–235.** Apparatus complete with two linen testers . **1.05**

75–156 **TUBE** only, without linen testers . . . . . **.20**

75–161 **RULED CARDBOARD STRIP,** after Fuller and Brownlee (Experiment **49A**) . . . . . **.30**

75–163 **CARDBOARD INDEX STRIP,** after Fuller and Brownlee (Experiment **49A**) . . . . . **.20**

No. 75–165

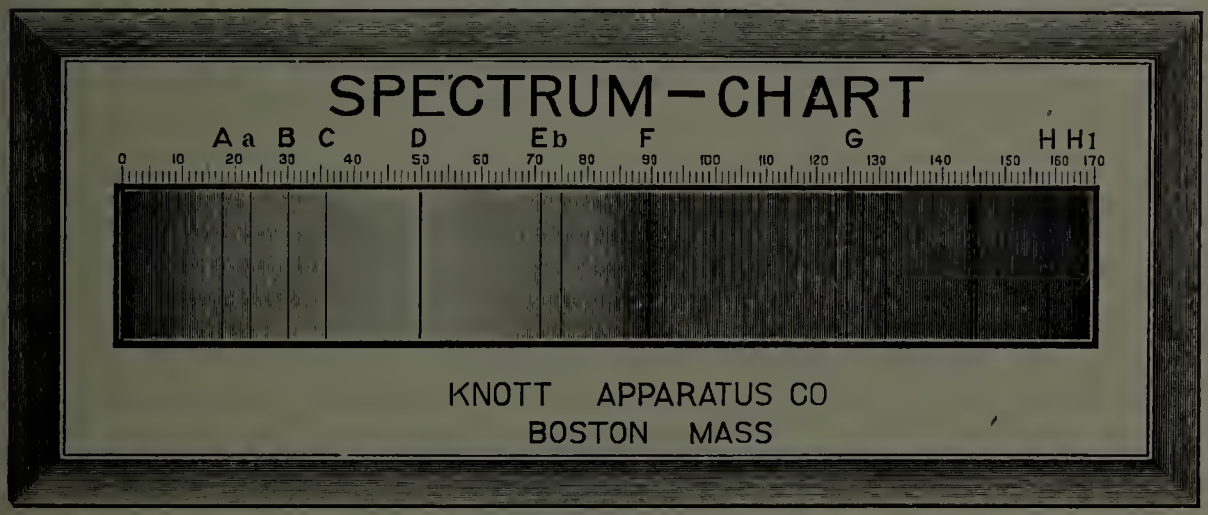


No. 75–170

75–165 **SEXTANT,** for measuring the angle between any two distant objects. This is a universal, durably constructed aluminum model, divided on main scale to read to degrees. The vernier on index arm is graduated so that six divisions on vernier equal five on the main scale.
This model must not be confused with a number of cheap models at present on the market, as this is an accurately working instrument provided with most of the adjustments of an engineer's and mariner's expensive metal sextant **$14.00**

75–170 **REFLECTING SEXTANT** for measuring the angle between any two distant points.
This is an accurately constructed, brass sextant capable of exact determinations, reading by vernier to 5 minutes of arc. It is provided with an astronomical telescope of 12 millimeters' aperture and with blend glasses as illustrated . . . . . Duty Free . . .

DIFFRACTION OF LIGHT



No. 77–75

77–75 **SUN SPECTRUM CHART,** hand painted on linen, spectrum band about 48 inches long by 7 inches wide. Frauenhofer lines indicated and colors carefully matched and work well executed. Mounted in frame to occupy wall space of about 5 × 2 feet . . . . . Duty Free . . .

77–80 **SPECTRUM CHART,** after Kirchhoff and Bunsen, showing beautifully the spectrum of the Sun, K, Rb, Cs, Tl, Na, Li, Ca, Sr and Ba. Mounted on linen back with common rollers **$4.25**

77–82 **SPECTRUM CHART,** after Kirchhoff and Bunsen, showing the following spectra: In, C, Bo, Mn, Pb, Cu, Co, Ni and Fe. Mounted on linen back with common rollers **4.25**

77–85 **SPECTRUM CHART,** illustrating the Solar Spectrum.
This Chart consists of a strip of paper on which the spectrum is beautifully lithographed. It is about 80 centimeters long and mounted on heavy cardboard. The various Frauenhofer lines are indicated **1.50**

21–210 **COLOR DISCS** for quantitative work in color mixing and color analysis.
Set of seven 10-inch discs of primary colors, one each of black and white, and a percentage circular protractor for quantitative work. (For illustration, see Section **21**) **2.00**

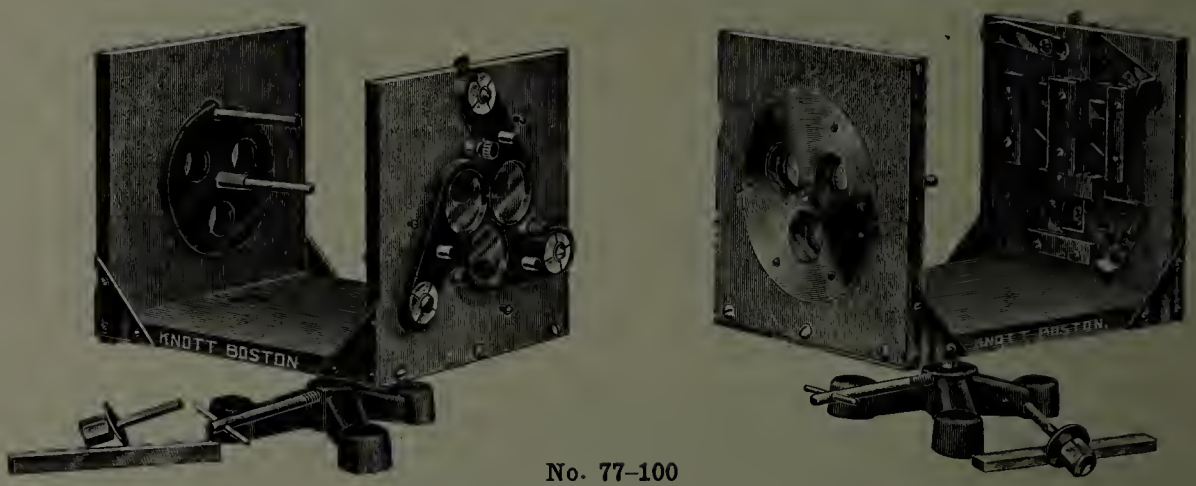
21–225 **COMBINATION NEWTON'S COLOR DISC** for showing white light when fixed portions of primary colors are rapidly rotated. (For description and illustration, see Section **21**) **1.50**

77–90 **COLORED GLASS PLATES** for analysis and study of light.
These plates are selected colored plates of the best "pot glass" colors. They are furnished 10 centimeters square in the following colors: red, orange, yellow, green, blue, indigo and violet.
Per set of seven colors **1.50**

THE VON NARDROFF COLOR APPARATUS

DESIGNED FOR THE STUDY OF COLOR PHENOMENA

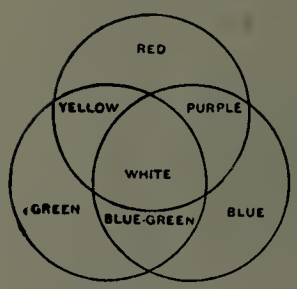
An Attachment for the Projection Lantern or Porte Lumiere
Made under the personal supervision of Mr. F. W. Huntington



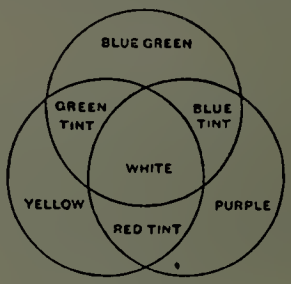
No. 77–100

77–100 VON NARDROFF COLOR APPARATUS. This apparatus was designed by Dr. Von Nardroff, Principal of the Stuyvesant High School, New York City, for the convenient and satisfactory study of color phenomena where only one Projection Lantern is available. Our method of mounting is such that it is equally well adapted for use with the Porte Lumiere.

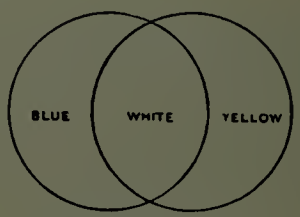
Briefly, it is an attachment that converts an ordinary Projection Lantern into a triple lantern in which each of the three beams of light is independent both as to intensity and direction. The general form and design will be clearly indicated by the cuts above, showing two positions.



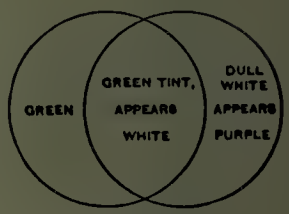
MAXWELL'S PRIMARY HUES.
Fig. 1.



FALSE PRIMARY HUES
Fig. 2



COMPLEMENTARY HUES.
Fig. 3.



CONTRAST EFFECTS.
Fig. 4.

EXPERIMENTS

A STUDY OF PRIMARIES AND SECONDARIES (see Fig. 1). The red, green, and blue glasses provided with the apparatus are placed in the glass holders shown in the diagram. By a movement of the lens arm these circles of red, green, and blue may be overlapped either in whole or in part as desired and, by means of the diaphragms, the intensity of strength of each color readily regulated. The effect of mixing the primaries in any desired portion, in pairs or in triples, is readily seen.

FALSE PRIMARIES (see Fig. 2). In this illustration the glasses selected should be the purple, yellow, and blue-green, and by proper manipulation of the diaphragms all possible hues, as well as white, may be obtained.

COMPLEMENTARY HUES (see Fig. 3) are easily illustrated by carefully choosing the pairs of colored glasses to obtain the desired results.

"THE GREEN QUESTION" is solved by super-imposing the yellow and blue glasses in the single slide holder of the apparatus and again inserting the same glasses in separate slide holders, adding the beams by over-lapping on the screen, noting that a pure white light is obtained.

CONTRASTING EFFECTS (see Fig. 4) are strikingly illustrated when a saturated color, such as green, is projected and the white disc arranged to partially over-lap turned on; the over-lap, which is really a tint, appearing nearly white, while the remaining white appears strongly colored of the complementary hue. If the order of projection is reversed, the sudden appearance of the white is very impressive.

A STUDY OF TINTS is easily made by adding to the white beam a colored beam adjusted for intensity.

OTHER EXPERIMENTS. Many additional experiments will suggest themselves to the user after he has become familiar with the apparatus and commences to learn some of its possibilities; such, for instance, as three equally bright beams being made to partially over-lap. The remaining portions of the beams will present intensities as the ratio of 1: 2: 3. Again, projecting on the screen a compound white, holding an opaque body in the path of the ray, a very remarkable shadow effect will be produced.

Price mounted as illustrated **$32.00**

SPECTRAL APPARATUS

Nos. 77–125 to 77–126

77–125 DIRECT VISION POCKET SPECTROSCOPE for use in experiments in Spectrum Analysis.
This instrument consists of a combination of three prisms giving a considerable dispersion. It will show many of the Frauenhofer lines, the bright lines of the metals and gases and the absorption bands in colored gases, crystals, or liquids. It is provided with an adjustable slit operated by a small micrometer screw. This spectroscope has an achromatic lens and is of excellent quality throughout.
Enclosed in velvet-lined case **$9.00**

77–126 ——, same as above, but fitted with a comparison prism which will show two spectra in the field of view at the same time, so that they may be conveniently compared.
Enclosed in velvet-lined case . . . . . Duty Free **14.50**

No. 77–160

77–160 DEMONSTRATION SPECTRAL APPARATUS AND GONIOMETER, — a goniometer or spectrometer of simple design but accurate construction, in which all lenses, diaphragms and slit are separately mounted and arranged for adjustment along nickel-plated graduated metal bars. The prism table and circle is accurately divided on metal to two degrees.
Although primarily designed for demonstration purposes, it will be found of unusual value as a student's instrument, in that the student is enabled, not only to use the instrument as a spectral apparatus with a fair degree of accuracy, but also to use it with a correct understanding of construction of telescope and collimator and, from observation of correct position of parts arranged openly on this simple design, to clearly understand the more complex instruments.
Constructed of metal throughout, handsomely nickel-plated and oxidized. Complete with Holders, Slit and Lenses, but without Prism **$19.80**

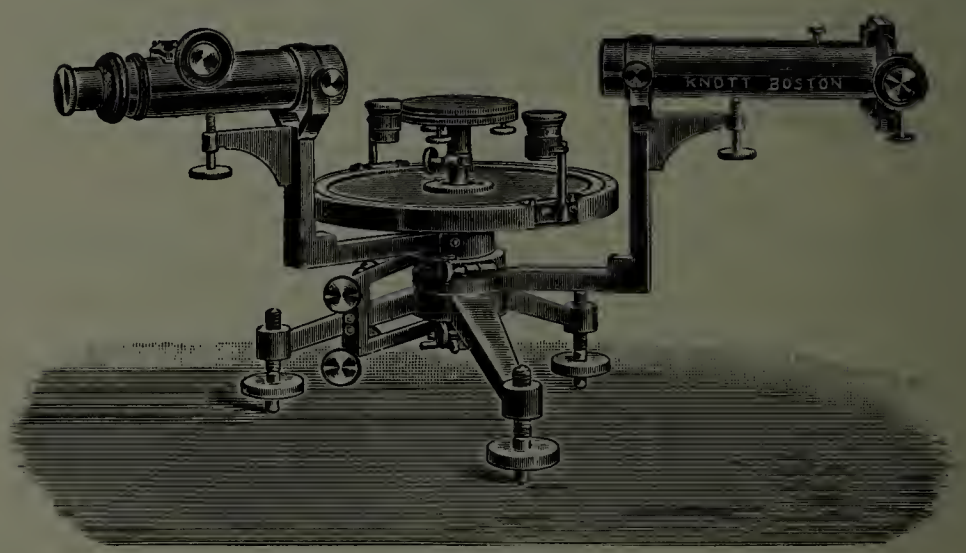
77–162 STUDENT'S SPECTROSCOPE. Many teachers have felt the need of an inexpensive instrument capable of demonstrating to students, in a convenient manner and without loss of time, the methods of spectrum analysis.
The spectroscope illustrated is provided with a set of prisms of high dispersion and yields a wide spectrum, showing a large number of Frauenhofer lines. The adjustment of focal length is secured by means of a small handle sliding along the tube. The fixed slit at one end is covered by a glass plate so as to be completely protected from dust. The spectrum in consequence will be free from cross-lines. The instrument is mounted on a neat wooden stand and is provided with holder for test tubes . . . . . Duty Free . . . .

No. 77–162

No. 77–170

77–170 ADVANCED SPECTROSCOPE. This instrument is especially designed for high school and elementary college work. It is furnished completely equipped with all essential parts.

All mechanical details are well constructed and nicely fitted; all optical parts are of the best. The telescope is adjustable, has an aperture of about 20 millimeters and a focal length of about 160 millimeters. The collimator is provided with a comparison prism and is of the same dimensions as the telescope. A separate tube contains the scale. The instrument is mounted adjustably in a neatly finished tripod stand. It is furnished with a 60-degree flint glass prism and provided with a cover for same . . . Duty Free . . .

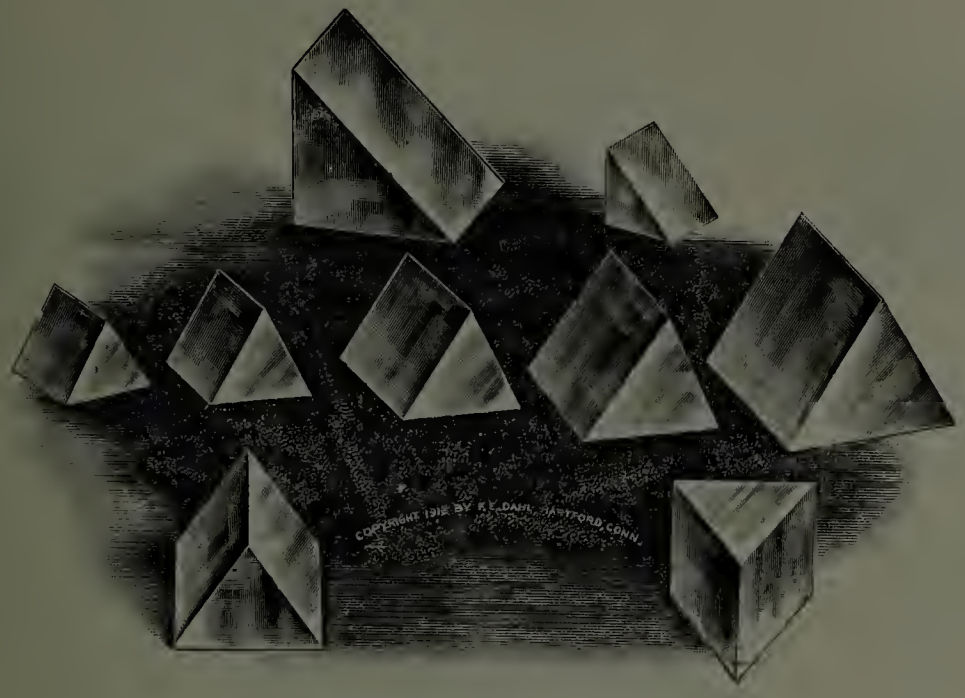


No. 77–175

77–175 UNIVERSALLY ADJUSTABLE SPECTROMETER, after V. v. Lang.

The adaptability of this instrument to most spectrometric work has made it one of the most popular spectrometers in use. Constructed by one of the most prominent European manufacturers, it has received every attention in structure. Mechanical parts are accurately constructed and carefully fitted; optical parts calculated to a nicety for the work for which the instrument is intended.

The circle is 120 millimeters in diameter with graduations on silver to ½ degree. To facilitate in the reading, the instrument is provided with two verniers with magnifiers which facilitate readings to 60 seconds of arc. The telescope has an aperture of 20 millimeters, is provided with rack and pinion adjustment and may be rotated about the vertical axis. The collimator has same diameter as the telescope and is provided with a slit with micrometer screw adjustment, the extent of opening being indicated on the graduated drum. The prism table is adjustable in height and may be leveled by three small thumb screws noted in the illustration. The instrument is mounted on a neatly finished tripod base provided with leveling screws. All necessary adjustments for telescope tube and collimator and locking device for the latter are provided. This instrument will give universal satisfaction . . . . . Duty Free . . .



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No. 74–367
Nos. 74–350 a-e to **Nos. 74–360 a-e**
Nos. 74–390 a-c **Nos. 74–400 a-c**

74–350 **FLINT GLASS EQUILATERAL SPECTRAL PRISMS,** optically true surfaces, square ends. Refractive Index for D = 1.602. Dispersion C–F = 1° 58′. Minimum for M/D = 55° 20′

	a	b	c	d	e
Side	25	30	35	40	50 millimeters
Each, Duty Free	**$4.75**	**5.25**	**6.25**	**7.40**	**9.75**
Each from Stock	**6.25**				

74–360 **CROWN GLASS EQUILATERAL SPECTRAL PRISMS,** optically true surfaces, square ends. Refractive index for D = 1.517; Dispersion C–F = 41°. Minimum for M/D = 50° 24′

	a	b	c	d	e
Side	25	30	35	40	50 millimeters
Each, Duty Free	**$4.75**	**5.25**	**6.25**	**7.40**	**9.75**
Each from Stock	**6.25**				

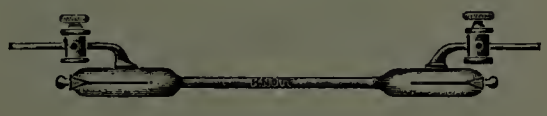
74–365 **CROWN GLASS SPECTRAL PRISM,** angles of 45 and 90 degrees, cathetus 25 millimeters. Duty Free **$5.25**

74–367 **CROWN GLASS SPECTRAL PRISM,** angles of 45 and 90 degrees, cathetus 50 millimeters. Duty Free **9.40**

74–370 **RUTHERFORD'S COMPOUND PRISMS,** consisting of a flint glass prism luted between two crown glass prisms.

	a	b	c	d	e
Side	20	30	40	50	60 millimeters
Each, Duty Free	**$9.75**	**14.50**	**23.25**	**38.50**	**49.75**

Nos. 77–225 to 77–236

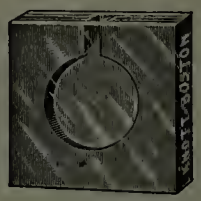


No. 77–245

77–225 **GEISSLER SPECTRUM TUBE,** filled with carbon dioxide **$1.95**
77–226 ——, filled with hydrogen gas **1.95**
77–227 ——, filled with nitrogen gas **1.95**
77–228 ——, filled with oxygen gas **1.95**
77–235 **GEISSLER SPECTRUM TUBE,** most carefully constructed, evacuated, and filled with pure argon gas **7.75**
77–236 ——, same as above, but filled with pure helium **7.75**
77–245 **GEISSLER SPECTRUM TUBE** for exhausting and filling with whatever gas desired. Fitted with two carefully ground glass cocks **1.95**

ABSORPTION TROUGHS

No. 77–265



No. 77–267

No. 77–270

77–265 **ABSORPTION TROUGH, U-SHAPED,** for use as an absorption vessel, light filter or for projection of living matter in liquids.
This trough is durably constructed and the cementing is guaranteed not to leak, being baked in special furnaces at 1000° F. Size 50 millimeters high, 20 millimeters wide, and 4 millimeters deep **$1.65**

77–267 **ABSORPTION TROUGH,** square shaped, with round bore, the same careful construction as above. Inside measurement 20 × 4 millimeters **1.45**

77–270 **DOUBLE ABSORPTION TROUGH** for comparing two liquids simultaneously, same careful construction as above. Inside measurement of each partition, 40 × 25 × 10 millimeters **4.85**

No. 74–438

74–438 **WEDGE-SHAPED TROUGHS,** a pair of prism-shaped troughs, each 6 inches long by 2 inches high. Refractive angles of 20 degrees . . . . . Duty Free **$5.50**

No. 77–300

77–300 **ADJUSTABLY MOUNTED FRESNEL'S INTERFERENCE MIRRORS** for illustrating interference of light by reflection.
The apparatus consists of two optically plane black glass mirrors the polished surfaces of which extend right up to the line of intersection of the two faces. These mirrors are provided with **Micrometer Screw Adjustments,** so that the angle between them may be varied within short limits. For normal use, these mirrors should be at nearly 180 degrees of angle in order to get proper interference. By means of the micrometer screw attachment, however, the complete system of fringes can be caused to pass in succession over any desired part of the screen. The mirror frame is attached to a rod for use with our No. **5–810** Right Angle Clamp for use on an Optical Bench
Duty Free . . .

77–305 **MOUNTED FRESNEL'S BI-PRISM** for showing interference of light by transmission. Duty Free . . .

DIFFRACTION GRATINGS

77–315 PRISM GRATINGS for spectroscopic and lantern work. Prism Gratings have been designed for obtaining direct vision spectra of great dispersion, while their brilliancy is far greater than plate gratings. They are made of varying angles and sizes to suit requirements and are equal in many cases to 4 to 6 flint prisms, the amount of dispersion being affected by the angle at which the prism is tilted. The surfaces of **a, b,** and **c** are accurate to 1/500,000 and of **d** and **e** to 1/50,000 of an inch.

	a	b	c	d	e
Size of Face	61 × 48	38 × 30	28 × 19	64 × 38	28 × 19 millimeters
Each, Duty Free					

Nos. 77–320 to 77–325

77–320 TRANSMISSION DIFFRACTION GRATING. These gratings are moulded replicas of Rowland's celebrated metallic gratings of 14,438 lines to the inch. They are mounted on parallel plate glass and are suitable for work of the highest class, both visual and photographic, as well as for projection purposes, and give a brilliant and pure normal spectra. Wave length measurements may be safely taken, as each grating has the number of lines per inch marked on it. Size, 28 × 19 millimeters . . . . . Duty Free

77–322 ——, same quality as above, but 54 × 35 millimeters . . . . . Duty Free

77–325 TRANSMISSION DIFFRACTION GRATING, same size as No. **77–322,** but on optically worked glass, giving a very brilliant spectrum . . . . . Duty Free

No. 77–350

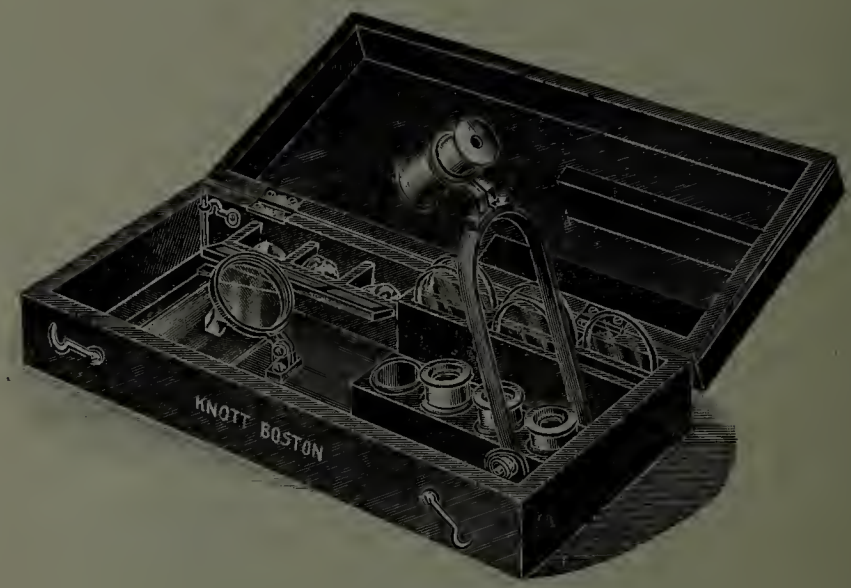
77–350 NEWTON'S RINGS for illustrating colors of thin plates, demonstrating interference of light, etc. This apparatus consists of two brass rings between which are locked two glasses, one plane and the other convex, of very long focus. The method of locking the two rings is such that by means of the screws, the pressure may be regulated. Diameter of glasses, 1½ inches.

If the two surfaces are exposed to ordinary light in front of the window, so as to reflect light, there is seen at the point of contact a black spot surrounded by 6 or 7 colored rings, the tints of which become gradually less strong. If the glasses are viewed by transmitted light, the center of the ring is white and each of the colors is exactly complementary of that of the rings by reflection. If exposed to light from a monochromatic flame, an interesting study of the colored rings presents itself . . . . . **$ 1.45**

77–352 NEWTON'S RINGS, similar to above but of larger size. Diameter, 16 centimeters. Duty Free **13.50**

77–375 INTERFERENCE OF LIGHT PLATES, after Millikan and Gale, Figure 391 . . . . . Pair **.45**

POLARIZATION STUDY APPARATUS



No. 78–40

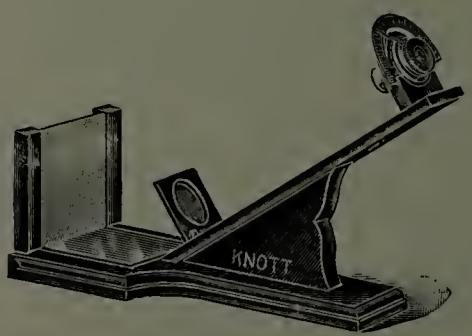
78–40 STUDENTS' POLARIZATION STUDY OUTFIT for study of effects of polarized light.

There is perhaps no branch of Optics so neglected and yet in which results are so important as that of Polarized Light. The neglect is due in a large measure to the elaborate and costly apparatus designed for this branch. To encourage the study we have secured from our European correspondents the design above illustrated.

With this comprehensive outfit, contained in a polished wooden box, each part appropriately mounted and a compartment for each, very beautiful results may be obtained. The Polarizing Black Mirror is mounted at one end, the holder for the Analyzer at the other, a Holder for the different crystals between. The Analyzer consists of a Nicol's Prism mounted in a brass tube. Four other brass tubes each with different crystals are furnished for use in the mounting with the Analyzer. Various Gypsum Figures and Specimens are furnished for study under polarized light.

We cannot too strongly urge the use of this simplified Study Outfit. All parts are carefully made and selections of crystals and specimens are those best adapted to study.

Complete as illustrated . . . . . Duty Free . . .



No. 78–45

No. 78–75

78–45 PICKERING POLARISCOPE for study of simple objects under polarized light.

This is a simple form of polariscope in which the Polarizing Mirror covers the stage. The Analyzer is a Nicol's Prism 6-millimeter aperture mounted in brass tube. It is provided with pointer and graduated arc. An improved Holder is provided for specimens to be studied **$8.00**

ICELAND SPAR. Iceland Spar is a crystallized mineral which produces two refracted beams of light from one incident ray.

Iceland Spar comes in many forms, all of which may be reduced by cleavage to the rhombohedron. This mineral comes in many grades of purity and clarity, although the double refraction can be shown by the quality readily obtained, and as generally listed. We recommend our No. **78–75.**

78–75 ICELAND SPAR, best quality, recommended for its remarkable purity and clarity **$0.75**
78–76 ICELAND SPAR, large size, medium quality . . . . . **.30**
78–77 ICELAND SPAR, ordinary quality . . . . . **.25**

No. 78–85

Nos. 78–95 to 78–100

No. 78–87

TOURMALINE TONGS. Tourmaline is a uni-axial negative crystal in the form of a regular hexagonal prism from which only the "extraordinary" ray emerges, while the "ordinary" is rapidly absorbed. It can, therefore, be used in producing a polarizing light. The optical axis of tourmaline coincides with the prism and for optical purposes the plate is cut from it parallel to the axis.

In tourmaline tongs used for illustrating and analyzing polarized light, two tourmaline crystals are mounted in discs which are held as illustrated. These discs are each free to move. If the prisms are placed so that their axes are parallel, light emerges as the prisms are turned so that their axes are at an angle. In use, the crystal to be studied under polarized light is placed between the two crystals.

78–85 TOURMALINE TONGS, simple form, medium size tourmaline prisms, capable of ordinary work . **$2.25**

78–87 PARALLELLY ADJUSTABLE TOURMALINE TONGS, superior quality tourmaline plates with improved mounting, which allows of wide separation of the plates; also convenient method of turning the tourmaline holders . . . . . Duty Free **11.40**

NICOL'S PRISMS

The ray of light incident on the crystal of Iceland Spar is split into two rays, the "ordinary" and the "extraordinary," each of which travels in a different plane. In order that the incident ray may be transmitted in one plane it is necessary to dispose of either the "ordinary" or "extraordinary" ray. The Nicol's Prism causes the "ordinary" ray to be totally reflected, allowing the free transmission of the "extraordinary" ray.

These types of prisms consist of rhombs of Iceland Spar, each of which is obliquely cross-cut symmetrical to the other. Faces polished and then luted by the cement the index of refraction of which is greater than that of the "extraordinary" ray. This cross cut is of such an angle that total reflection of the "ordinary" ray occurs when the incident ray strikes the luted faces.

Our Nicol's Prisms are purchased from one manufacturer and are noted for their large polarizing field and their exceeding clarity. We have no hesitation in recommending either those which are carried in stock or those which we list herewith, free of duty.

78–95 NICOL'S PRISMS, luted by Canada Balsam, polarizing field of 22½ degrees.

	a	b	c	
Aperture	6	7	8	millimeters
Each	**$3.30**	**4.90**	**5.40**	

78–97 ——, same as above, but larger aperture.

	a	b	c
Aperture	15	20	25
Each, Duty Free . .	**$9.25**	**22.25**	**45.00**

78–100 NICOL'S PRISMS, luted with evaporated linseed oil. Aperture ⅓ of length, polarizing field 30 degrees.

	a	b	c	d	e	
Length	21	24	27	30	45	millimeters
Each, Duty Free . .	**$5.90**	**7.25**	**9.80**	**14.25**	**37.50**	

78–110 FOUCAULT'S PRISMS. The Foucault's Prism is a type of Nicol's Prism remarkable for its clarity, the luting being a stratum of air. Polarizing field 8 degrees.

	a	b	c	d	
Aperture	20	25	30	35	millimeters
Each, Duty Free . .	**$7.25**	**14.50**	**24.00**	**29.50**	

OBJECTS FOR THE POLARISCOPE

No. 78–140

78–140 **UNANNEALED (IMPERFECTLY ANNEALED) GLASS SPECIMENS.** Suddenly cooled glass exhibits double refraction. In consequence such specimens will show different patterns under a beam of polarized light.
Set of eight selected specimens as above illustrated . . . . . Duty Free **$12.00**

SELENITE DESIGNS EXHIBITING MOST BEAUTIFUL COLORS IN POLARIZED LIGHT

78–153 **FOUR SELENITE PLATES** together in four colors **$2.15**
78–154 **CUBE,** three colors **2.70**
78–155 **OCTAHEDRON,** four colors **3.40**
78–156 **STAR,** six colors **5.00**
78–157 **BUTTERFLY,** most beautiful effects **6.15**
78–158 **BOUQUET,** highly recommended for its many strikingly beautiful colors . . . . . Duty Free **9.50**
78–165 **UNCUT MICA,** for individual adjustment, set of six plates of different thicknesses . . . . . **.90**
78–170 **MICA PLATE,** ¼ undulation, 40 millimeter aperture **2.25**
78–172 ——, ¼ undulation, 30 millimeter diameter **1.60**
78–174 ——, ¼ undulation, 12 to 15 millimeter diameter **1.00**
78–175 **MICA PLATE,** ½ undulation, 12 to 15 millimeter diameter **1.00**
78–180 **MICA COMBINATION,** after Noremberg, collection of six pieces . . . . . Duty Free **6.25**
78–181 ——, after Noremberg, in one preparation . . . . . Duty Free **7.15**
78–185 ——, after Reusch, plates crossed under 60 degrees, turning right and left . . . . . Duty Free **7.25**
78–186 ——, after Reusch, plates crossed under 45 degrees . . . . . Duty Free **7.40**
78–190 **MICA WEDGES,** two Mica Wedges, eight steps, each wedge arranged, one to turn over the other. Per pair . . . . . Duty Free **7.50**
78–195 **MICA WEDGES,** 16 steps, ¼ to 4 undulations, in form of the object bearer, 11 × 70 millimeters. Duty Free **6.90**
78–205 **SELENITE PLATE,** between two ¼ undulation mica plates, aperture 40 millimeters. Duty Free **3.25**
78–207 **SELENITE DOUBLE PLATE,** between two ¼ undulation mica plates, aperture 40 millimeters. Duty Free **3.75**
78–210 **SELENITE AND MICA COMBINATION,** according to Wright, magnificent colors, collection of six pieces . . . . . Duty Free **7.00**
78–211 ——, same as above, but collection of eight pieces . . . . . Duty Free **9.75**
78–220 **SELENITE PLATE** for examining the character of double reflection by uni-axial crystal cuts, 40 millimeter aperture . . . . . Duty Free **6.25**
78–221 **SELENITE PLATE,** same as above, but 30 millimeter diameter . . . . . Duty Free **5.00**
78–225 **SELENITE PLATES,** in ¼, ¾ and ⅞ undulations, laid one to the other, giving thirteen different steps, for diffused light . . . . . Duty Free **5.40**
78–226 ——, same as above, but for sodium light . . . . . Duty Free **5.90**

PROJECTION APPARATUS

It is probable that more important changes and improvements have been made during the past few years in Projection apparatus than in any other department of laboratory equipment.

The various requirements of a well equipped laboratory are so numerous, ranging as they do from simple projection to moving pictures, that it requires long experience and critical judgment to select the proper equipment for any given laboratory.

We are prepared to recommend the very latest and best types of projection machines and will do so upon request. When writing to us upon this subject, please inform us of the size of the Class Lecture Room, or Auditorium, the size of the picture desired, whether or not electricity is available and if so the kind and the voltage, and all other local conditions which may assist us. We shall then be pleased to give detailed information as to the combination which we recommend.

MAGNETISM AND STATIC ELECTRICITY

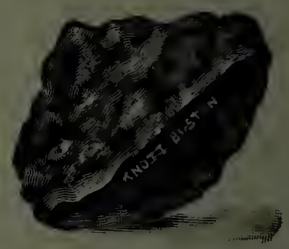
MAGNETS

Our line of apparatus illustrative of Magnetism and its various properties has been selected with great care. Our magnets are of the best quality steel and will retain their magnetism.

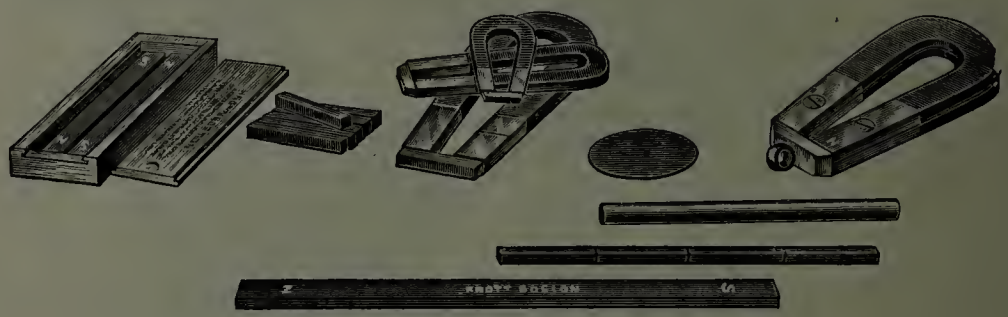
80–10 LODESTONE or NATURAL MAGNET. As suggested by the name, this magnet is a selected piece of iron ore having magnetic properties. It exerts attractive and repulsive force and is readily affected by the earth's magnetic power $0.22

80–11 LARGE DEMONSTRATION TABLE LODESTONE or NATURAL MAGNET, highest quality 65

80–14 SUPPORTING STIRRUP FOR LODESTONE, used in illustrating the action of the earth's magnetic force. This stirrup will contain either of the lodestones listed above 65



Nos. 80–10 to 80–11



HORSESHOE MAGNETS WITH KEEPERS

Numbers	80–20	80–22	80–24	80–26	80–28
Length, inches	2	3	4	6	8
Each	$0.08	0.11	0.18	0.48	1.00

80–30 HORSESHOE MAGNET, special design, 2 inches between poles. Length 5½ inches, poles ¾ × ½ inch $0.35

80–32 U-SHAPED MAGNET, after Fuller and Brownlee (Experiment 85) 40

80–35 COMPOUND HORSESHOE MAGNET, demonstrating the intensified magnetic force derived by the combination of more than a single magnet. Two magnets firmly clamped together with keeper . 1.70

80–37 EIGHT-INCH COMPOUND HORSESHOE MAGNET, consisting of four eight-inch single magnets firmly clamped together. With keeper 6.40

BAR MAGNETS, finest quality steel, excellent retentive quality, neatly polished.

Numbers	80–55	80–57	80–59	80–61
Size, inches	2 × ¼ × ¼	6 × ½ × ¼	8 × ½ × ¼	12 × 1 × ¼
Price . . Each,	$0.18	0.20	0.30	0.60
Per Doz.	1.50			

80–70 BAR MAGNETS, consisting of a pair of 6-inch Bar Magnets in neat wooden box, with keepers . .50

80–80 ROUND BAR MAGNET, excellent quality polished steel, length 6 inches, diameter ⅜ inch 25

80–85 BREAKING MAGNET, illustrating the fact that both polarities of magnetism are present at all parts of the bar, and are not merely at the ends.
This Magnet is 6 inches long by ¼ inch square, weakened at various points to facilitate in the breaking 22

80–87 GLASS TUBE and STEEL FILINGS, illustrating the molecular character of magnetism.
This consists of a small glass tube filled with washed steel filings. If the filings are magnetized by the approach of a bar magnet, each small filing will attain the characteristics of a magnet, attracting and repelling adjacent filings, so that they will all cluster together to form a solid mass. This condition may be destroyed by violently shaking the tube, thus destroying the magnetism 30

80–90 MAGNETIZED STEEL DISC, useful in destroying the conception of the students that magnets must be in the form of rods or bars.
This disc is 2 inches in diameter and has two distinct magnetic poles 55

80–100 **HARDENED STEEL RODS (KNITTING NEEDLES)**, about 1/16 inch diameter by 8 inches long. These steel rods are useful in the study of Breaking Magnets. Per set of four $0.05

80–102 **LARGE DARNING NEEDLES.** Package of 25 needles 06

80–105 **SOFT IRON BAR,** for illustrating the action of the earth on magnetic substances; may be used also to illustrate the formation of magnets by enclosing in a solenoid through which passes a current of electricity.
This bar is of the best quality of soft Norway iron and measures 6 × ½ × ¼ 20

80–106 **SOFT NORWAY IRON ROD,** 20 inches long by ½ inch diameter, for studying the action of the earth on magnetic substances. When this bar is held in the magnetic meridian parallel to the inclination, feeble magnetic polarity is at once noticeable in the bar, the lower extremity being the North Pole, as may be demonstrated by testing with a small magnetic needle. This magnetism is unstable, as may be demonstrated by inverting the bar. The magnetic polarity, however, may be made somewhat more stable by imparting to the bar a certain amount of coercive force by giving it several sharp blows with a hammer. This coercive force is, of course, very small, and after a time the magnetism entirely disappears 40

80–107 **SOFT IRON HORSESHOE CORE,** after Millikan, Gale and Bishop (Experiment **30**) 10

80–108 **CYLINDRICAL IRON ARMATURE,** after Turner and Hersey (Experiment **E011**) 04

80–109 **TWO-PART IRON ARMATURE,** after Turner and Hersey (Experiment **E011**) 04

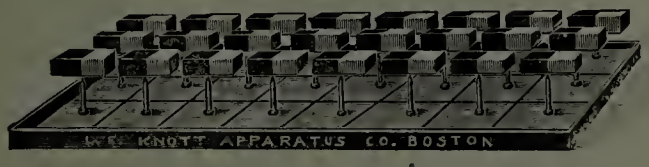
80–110 **NICKEL STRIP** for illustrating that other substances than iron have magnetic properties.
This strip is 4 × ¼ inch 30

80–115 **MAGNETIC SCREENS** for illustrating magnetic transparency, consisting of a set of six screens of different substances, some paramagnetic, others diamagnetic . . . . . Per set of six .70

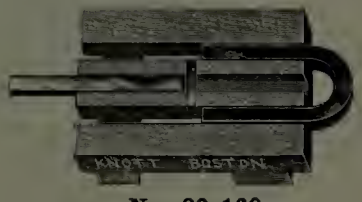
80–117 **PARAMAGNETIC AND DIAMAGNETIC SUBSTANCES** . . . . . Package .40

80–120 **MAGNET STIRRUP,** for the study of magnetic action in a suspended bar magnet.
This consists of a wire stirrup with a device for holding magnets and also for attaching to a support by a string 10

No. 80–123



No. 80–150



No. 80–160

80–123 **BLACK'S MAGNET and FRICTION ROD SUPPORT.** The magnet or friction rod carrier is constructed of very light weight metal and when balanced as illustrated on the hardened steel supporting needle, moves with very little inertia. A magnet or friction rod resting on this carrier, therefore, reacts readily to other magnetic or static charges $1.60

80–150 **MOLECULAR MAGNET MODEL** for explaining the distribution of Magnetism in magnetic rods.
This apparatus consists of twenty-four small magnets about 2 centimeters long, each supported on a point and all placed as illustrated, on an insulated board. These magnets will arrange themselves so that the like poles all point in one direction. If, however, the pole of a strong Bar Magnet be presented to one end, the needles will be immediately deflected.
Set of twenty-four, mounted as illustrated . . . . . Duty Free 9.25

80–155 **FLOATING MAGNETS** for illustrating the attraction and repulsion of magnetic poles.
This apparatus consists of a set of six small magnets each on an individual mount that will float in water . . . . . Per set of six .20

80–160 **SUPPORTING BOARD** for use with a magnet and tracing paper for forming a tracing of the lines of force of a magnet.
This board, as shown in the illustration, has a groove in the middle into which the magnet is placed, bringing the surface of the magnet flush with the top of the board.
In use, a sheet of blueprint paper is pinned to the board over the magnet. Iron filings, sifted over this sheet, will arrange themselves in the lines of force of the magnet 45

80–165 **MAGNET SUPPORTS.** These supports consist of short strips of wood ¼ inch cross-section. They are designed for use with magnets No. **80–55.** The blueprint paper is placed on these wooden supports . . . . . Per Pair .05

80–167 **SPECIAL MAGNET BLOCK,** after Turner and Hersey (Experiment **E011**) 04

80–170 **GLASS PLATES** (6 × 6 inches), for use in mapping magnetic fields of force.
These plates may be used to advantage with No. **80–165 Supporting Strips,** and No. **80–55 Bar Magnet** . . . . . Each .10

80–180 **IRON FILINGS** for mapping magnetic lines of force. Selected, fine, soft iron filings.
Per ¼ lb. carton **$0.10**
Per lb. in bulk **.20**

80–185 **FILINGS SIFTER** for evenly distributing filings over a tracing surface . . . . . **.15**

80–187 **CHEESE CLOTH BAG** . . . . . **.10**

80–190 **BLUEPRINT PAPER** for permanently recording a magnetic field of force of a bar magnet, as indicated by iron filings. Size, 8½ × 10½ inches. Per light-proof, sealed package of 100 sheets . . **1.25**

80–200 **DIRECT BLACKPRINT PAPER,** more desirable than blueprint paper as it gives a black line on white ground.
This paper is treated like ordinary blueprint paper, except that the print should be left in the bath from 10 to 15 minutes . . . . . .Per 10-yard roll, medium weight, 30 inches wide . **2.75**

80–225 **LINES OF FORCE APPARATUS,** after Toepler, for showing the magnetic curves between the poles of an electro-magnet. Excellent in projection work.
This apparatus consists of a glass trough placed between the poles of an electro-magnet. This trough, in use, is filled with glycerine in which fine iron filings have been previously mixed. When a current is allowed to pass through the electro-magnet, the small particles of iron will arrange themselves in magnetic curves. This instrument forms an instructive and interesting piece of apparatus **$7.80**

No. 80–225

No. 80–230

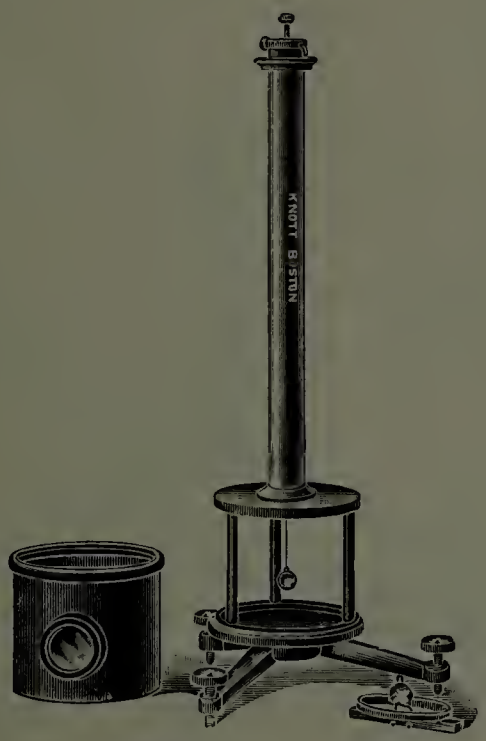
80–230 **MAGNETIC LINES OF FORCE APPARATUS** for use with a Vertical Projector in showing on a screen the lines of force about a current.
This apparatus consists of a set of six slides, each slide being a glass plate set in a wooden frame. Through holes bored in the glass, various forms of wire are set. In projection work, this set will be found invaluable . . . . . Per set of six slides **$9.75**

No. 80–232

80–232 **MAGNETIC LINES OF FORCE APPARATUS** for use with a Vertical Projector in showing on a screen the lines of force about a magnet.
This apparatus, similar to Set No. **80–230,** consists of a set of six slides, each slide consisting of two plates between which are placed thin steel magnets of various forms and differently arranged as illustrated . . . . . Per set of six slides **$2.50**

80–235 **MAGNETIC LINES OF FORCE SLIDES,** for illustrating on a screen the fields of force shown by iron filings.
These slides are direct photographs and are selected from our Miller Collection. The set consists of five slides illustrating the field of: (1) **Single Bar Magnet;** (2) **Two Bar Magnets, Unlike Poles;** (3) **Two Bar Magnets, like Poles;** (4) **Two Bar Magnets at Right Angles;** (5) **Ring Magnets.**
Per set of five **2.00**

MAGNETOMETERS



Nos. 80–250 and 80–253

80–250 MAGNETOMETER, after Millikan and Mills' "Electricity, Sound and Light" (Experiment **2**), for determining the magnetic moment (M) and horizontal component of the earth's magnetic field (H), by first determining the relation M/H and MH.

This magnetometer is carefully designed to do accurate work. The suspension system consists of five small magnets, cemented to the back of an optically plane glass mirror. This system is held by a silk fibre suspended from the graduated torsion head. The brass housing is so mounted on the tripod that it may be turned about a vertical axis. The outer wall of this housing, with clear, flat glass window, may readily be removed as illustrated, without disturbing the suspension system.

Magnetometer complete with Suspension System **$18.00**

80–252 MAGNET AND METER ROD SUPPORTS. In determining the value M/H a bar magnet of a size determined by the diameter of the lower part of the housing and an appropriate support for the same, east and west of the suspended system, are needed. These supports utilize the standard meter stick found in all laboratories. The meter rod is supported by special brass castings; the magnet support is designed to rest on the meter stick wherever desired. An index on the magnet support enables one to make an accurate reading of the distance of the magnet from the magnetometer mirror.

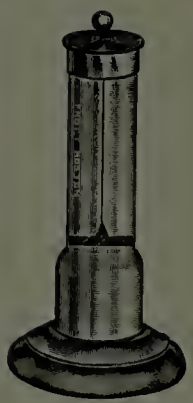
One pair special brass Meter Rod Supports and Magnet Holder **1.40**

80–253 INERTIA ACCESSORIES for use with above Magnetometer, in determining the moment of inertia of the magnet of No. **80–250.**

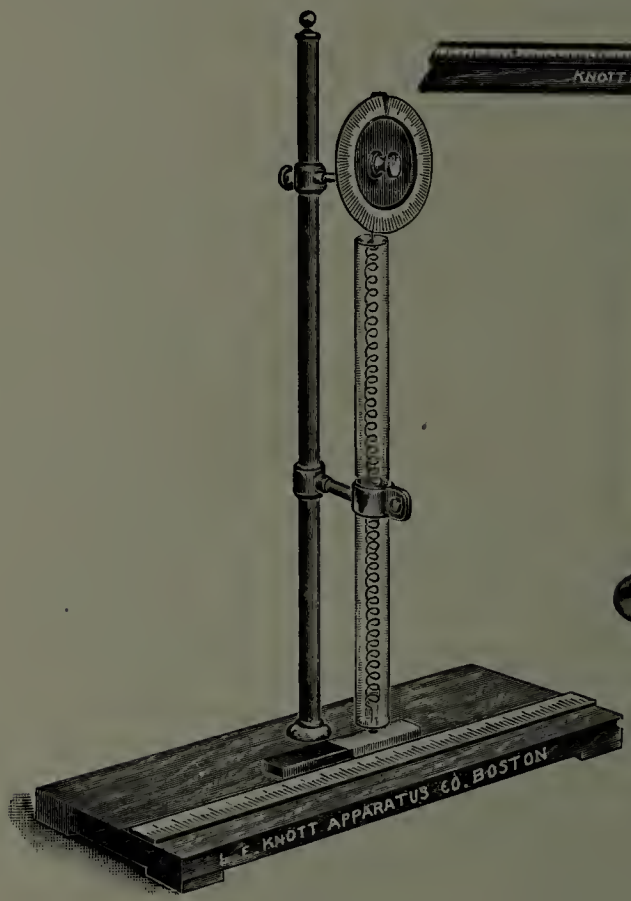
This system consists of a stirrup to which is attached a plane mirror and which is designed to hold the magnet. That results may be checked, a brass inertia ring is supplied.

Inertia Ring, Magnet, and Stirrup with Attached Mirror **3.15**

No. 80–270



No. 80–280



No. 80–265

No. 80–300

80–265 SPRING MAGNETOMETER, after Stewart & Gee's "Elementary Practical Physics," Lesson XIII, for determining the distribution of magnetism along a bar magnet.

In use, the zero point is obtained by substituting for the magnet a piece of wood of the same dimensions, then turning the milled head until the soft iron piece just touches the surface of the wood. Place the magnet in position, and determine the number of divisions through which the milled head must be turned, to detach the iron piece. Readings should always be made from the middle of the magnet toward each end. From a number of such readings, it will be noted that the magnetic strength is directly proportional to the distance from the center.

Complete with Special Magnet and similar wooden strip $7.50

80–270 DEFLECTION MAGNETOMETER for comparing the strength of the poles of a bar magnet.

The apparatus consists of a polished mahogany base board to the surface of which is fastened a meter rod. Midway between the ends of this rod a delicate magnetic needle is placed, with the 50 centimeter division of the rod directly under the supporting pivot of the needle.

Complete with Magnetic Needle and Bar Magnet 2.25

80–280 MAGNETOSCOPE, after Chute's "Physical Laboratory Manual," Problems 104 to 106, for measuring relative magnetic transparencies of various substances; for comparing strength of poles and determining distribution of magnetism along a bar magnet.

This simple instrument, capable of relatively exact measurements, consists of a heavy jar of special design, mounted on a wooden pedestal. A strongly magnetized permanent magnet is suspended through a stopper plug 95

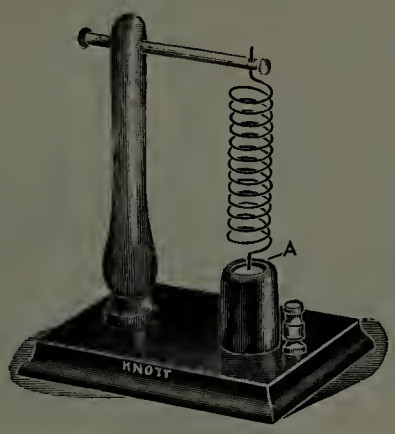
80–300 MAGNETIC POLE ROTATION APPARATUS for demonstrating the tendency of a current and a magnet pole to rotate about each other.

The apparatus consists of a jewel-mounted magnet supported so that the current passes along half the length of the magnet and is carried away at the middle. The magnet is supported at its center on a fine point on top of a post. The current is brought to a mercury cup fitted to the magnet, and a bent copper wire attached to this cup dips into an annular mercury cup, whence it is carried away by the upright support to which the cup is attached. When a strong current is passing (3½ amperes at 7 volts pressure, at least) one pole will rotate steadily. By reversing the direction of the current, the direction of the rotation is reversed.

Complete as illustrated 4.35

80–115 MAGNETIC SCREENS, set of six screens of different substances, some paramagnetic, others diamagnetic 70

No. 80–305



No. 80–310

80–305 **PARALLEL CURRENT APPARATUS** for illustrating mutual actions of parallel currents. The design consists of an insulated stand to the head of which are attached binding posts in electrical connection with two bent copper wires. To these bent wires are suspended two straight copper rods cut to lengths that will allow their free ends to extend within the mercury well set in the base.

In use it is always best to amalgamate the ends of these copper rods. Success of the experiment depends also upon allowing the rods to just make contact with the surface of the mercury. Parallel currents flowing in the same direction may be secured by connecting both binding posts with one pole of the battery; the other pole should be connected to a binding post (not shown in illustration) fastened to the base and in electrical connection with the mercury well.

Parallel currents running in opposite directions may be obtained by simply connecting the battery terminals and the binding posts, at the top.

In the first case, repulsion of the wires will be noted; in the second attraction **$1.85**

80–310 **VIBRATING SPIRAL APPARATUS** for illustrating mutual action of parallel currents.

The apparatus consists of a stand with upright. In the base is set a mercury well in electrical connection with a binding post. A horizontal rod set into the upright near the top is provided at one end with a binding post and at the other with a binding screw, the latter designed to support one end of a loose copper wire spiral. The other end of this spiral extends within the mercury well. In use, this end should be regulated to just touch the surface of the mercury. When a current is allowed to pass through the spiral, there is an attraction between the convolutions, causing the lower end of the spiral to break the electrical connection with the mercury. The weight of the spiral then causes contact again, which, in turn, sets up attraction of the convolutions. Continual making and breaking contact with the mercury causes this spiral to vibrate up and down **1.35**

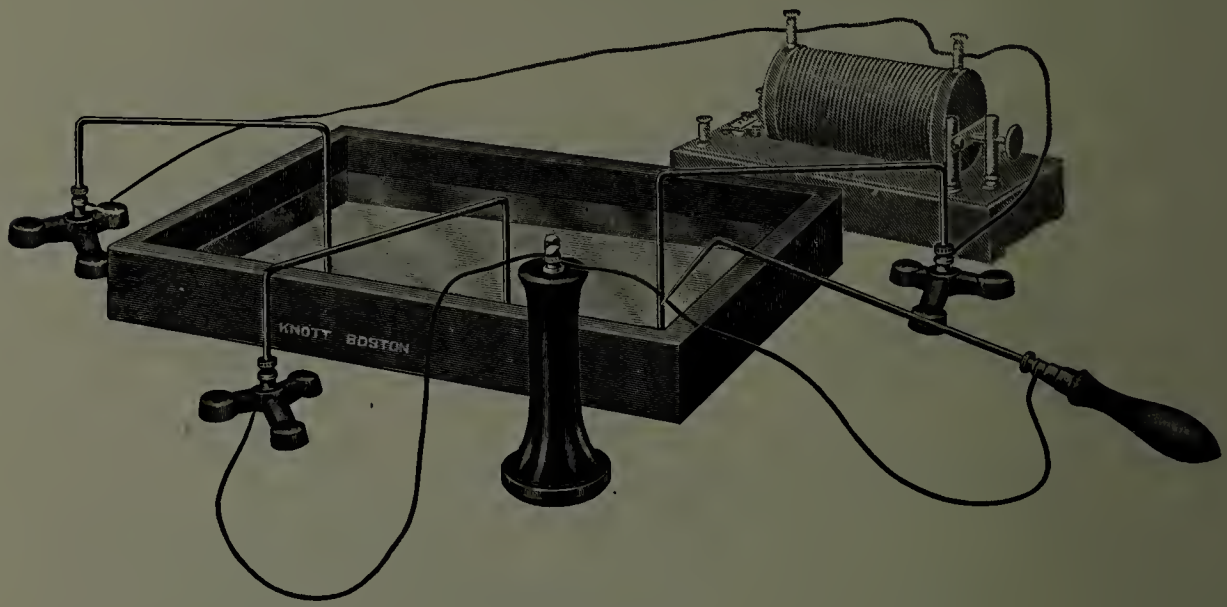
No. 80–325

80–325 **MAGNETIC DISTRIBUTION APPARATUS,** after Stewart & Gee's "Elementary Practical Physics," Lesson **LXXII,** for studying the distribution of magnetism along a soft iron bar magnetized by induced currents from a magnetizing helix.

This apparatus consists of a long, soft, Norway iron bar, mounted on supports as illustrated. At the end are two short pieces of brass of the same diameter as the iron rod, permitting the whole length of the iron rod to be brought under experimentation. For magnetizing purposes a test coil which may be clamped to any part of the bar, is supplied. A small reel wound with fine wire is employed as the induction coil. The range of play and the position of the test coil is determined by two brass guides between which this reel is placed. The guide and reel are each provided with screws for clamping to the rod.

Complete as illustrated **$9.65**

EQUIPOTENTIAL APPARATUS



No. 80–350

80–350 EQUIPOTENTIAL DETERMINATION APPARATUS, after Millikan & Mills' "Electricity, Sound, and Light" (Experiment 1), for mapping the equipotential surface of an electrical field and drawing the force lines.

The apparatus consists of a field tray with glass bottom, through which may be seen a sheet of co-ordinate paper. This tray is an improved design by C. H. Andrews, South High School, Worcester, Mass. With this design it is impossible for the salt solution to come into contact with the paper, and the whole tray may be thoroughly cleaned without removing the glass plate. It has the further advantage, also, of facilitating the replacing of broken plates. Three bent wires, each with weighted support and binding post, are provided. Two of these are maintained at points of different potentials and about which it is desired to find equal potential lines which lie in one plane. A constantly varying potential difference is secured by connecting these points to the secondary of an induction coil. A fourth bent wire with insulating handle and binding post is used with the third point as illustrated in locating the points of equipotential. The fourth point may then be considered the equipotential seeker.

In use, the bottom of the tray is covered with a solution of ammonium chloride or any convenient salt. The bent wires then are located as illustrated, two connected to the secondary of an induction coil the primary of which is connected to a dry cell, the third and the equipotential seeker are connected to telephone receiver. By adjusting the position of the third wire to various points in the plane of the liquid, points of equipotential for these different points may be located by means of the seeker. These points will be found when there is no "buzzing" in the telephone receiver. Results may be transferred to a sheet of co-ordinate paper and equipotential lines and the lines of flow drawn.

Complete apparatus consists of the Field Tray and the four bent wires, three with weighted supports and binding posts, the fourth with insulating handle. Complete $6.00

80–351 FIELD TRAY, improved design by Andrews 4.00

80–352 BENT WIRE, WITH WEIGHTED SUPPORT AND BINDING POST . . . . . Each .50

80–353 BENT WIRE, WITH INSULATING HANDLE AND BINDING POST . . . . . Each .50

19–67 CO-ORDINATE PAPER, ruled 6 × 8 inches on sheet 8½ × 10½, millimeter ruling, heavy centimeter divisions . . . . . Per 100 sheets .60

80–355 INDUCTION COIL, small size with modified hammer, especially adapted to this work 4.00

98–100 BIPOLAR DISSECTIBLE TELEPHONE RECEIVER, as above illustrated 1.45

TERRESTRIAL MAGNETISM

MAGNETIC NEEDLES

No. 81–10

No. 81–15

81–10 **MAGNETIC NEEDLE,** brass capped, agate bearing, neat stand with pinion, needle 6 inches long . . **$0.90**

81–12 ——, same as above, brass capped only . . . . . **.60**

81–15 **ASTATIC NEEDLE,** improved design, brass caps, neat stand with pinion, needle 6 inches long, system mounted so that like or unlike poles may be opposite each other **1.40**

No. 81–50

No. 81–55

81–50 **STUDENTS' DEMONSTRATION DIP NEEDLE,** as designed by W. R. Pyle of Morris High School, New York City.
This instrument consists of a stand on which may be supported the dipping system. It is intended that this system should be magnetized by the student. For this purpose, there are supplied four steel rods $\frac{1}{16}$ inch diameter, about 8 inches long. Our dipping system consists of a device whereby one of these steel rods may be mounted and balanced unmagnetized and clamped in the system. The needle is then magnetized by stroking from the middle toward each end with a strong bar magnet. The dip, then, may be taken and noted. This little instrument has found ready favor in many schools and is highly recommended for its didactic features **$0.95**

No. 81–60

81–55 **DIPPING NEEDLE** for showing magnetic dip.
This design consists of a standard on which is mounted a forked casting. In this forked casting is mounted, in pivotal bearings, a carefully magnetized and balanced needle. A graduated arc, also mounted in this forked casting, gives the magnetic dip **$3.30**

81–60 **DIP NEEDLE.** This instrument, of the highest quality, and capable of exact determinations, consists of a horizontal circle mounted on a tripod with leveling screws. Above the circle is a pillar movable about a vertical axis and ending above in a forked stirrup, designed to support the dip system. This system consists of a silvered-metal engine-divided circle fitted between brass stirrups which act as a support for the needle. Set screws fitted with cones and lock nuts carry the hardened steel axis of a delicately balanced needle. The sensitive spirit level mounted on the pillar facilitates leveling . . . . . Duty Free **17.50**

COMPASSES

No. 49–27

49–27 **MINER'S COMPASS or DIPPING NEEDLE,** a serviceable guide to the location of magnetic iron ore.

In this instrument the magnetic needle is horizontally balanced on an axis within a graduated circle and in which the needle will be found to assume a position inclined to the horizon. When used for tracing ore, the observer should hold the ring in his hand and keep the needle north and south, standing with his face to the west. The inclination of the needle as read on the graduated scale will show the dip. If the compass is held horizontally, it serves as an ordinary compass. This compass is handsomely finished with raised silvered-metal graduated scale, and is 3½ inches in diameter. It is provided with a brass cap cover and is enclosed in a neat plush-lined box **$11.00**

Nos. 81–76 to 81–78

Nos. 81–85 to 81–87

No. 81–95

81–75 **MAGNETIC COMPASS,** consisting of small, delicately balanced needle mounted in polished brass case, with card dial, diameter 12 millimeters . . . . . .Per Dozen **$1.40**

81–76 **MAGNETIC COMPASS,** similar to above, but 25 millimeters diameter, and supplied with ring . . **.18**

81–77 ——, same as above, but 35 millimeters diameter . . . . . **.25**

81–78 ——, same as above, but 50 millimeters diameter . . . . . **.33**

81–85 **MAGNETIC COMPASS,** superior quality, raised metal dial with full circle divisions, delicately balanced needle with brass-capped agate bearing enclosed in polished brass case, with stop for needle, diameter 30 millimeters **$1.05**

81–87 ——, same as above, but 50 millimeters diameter **1.30**

81–95 **MAGNETIC COMPASS,** raised metal dial, with full circle divisions, agate cap needle, with 37-millimeter aluminum pointer, enclosed in polished brass case, with stop for needle, diameter 50 millimeters **1.65**

81–100 **MAGNETIC POCKET COMPASS,** card dial, full circle divisions with cardinal points, needle with brass-capped bearing with stop, inside a polished mahogany box with hinged cover, diameter 2½ inches **1.25**

81–101 ——, similar to above, but silvered-dial and raised ring, needle with brass-capped agate bearing **3.00**

No. 81–100

No. 81–125

No. 81–130

81–125 **WATCH CASE SIGHT COMPASS,** 2¼ inches in diameter, excellent quality with full circle divisions on raised dial. Nicely balanced needle, 1¼ inches long, with agate bearing. Provided with folding sights. Spring cover **$6.60**

81–130 **BRIDGE SIGHT CLINOMETER COMPASS,** for use both as a clinometer and as a sight compass. This useful instrument is constructed to fulfill the office of both clinometer and sight compass. The sights are made in the form of a bridge and can be turned on their pivots at right angles.

The needle of this compass is a hardened and tempered edge bar with needle jeweled center. It is mounted within a three-inch bronze case provided with a silvered-metal dial **7.50**

No. 81–140

81–140 **MARINE COMPASS,** — a compass in which the moving system is floated in alcohol.

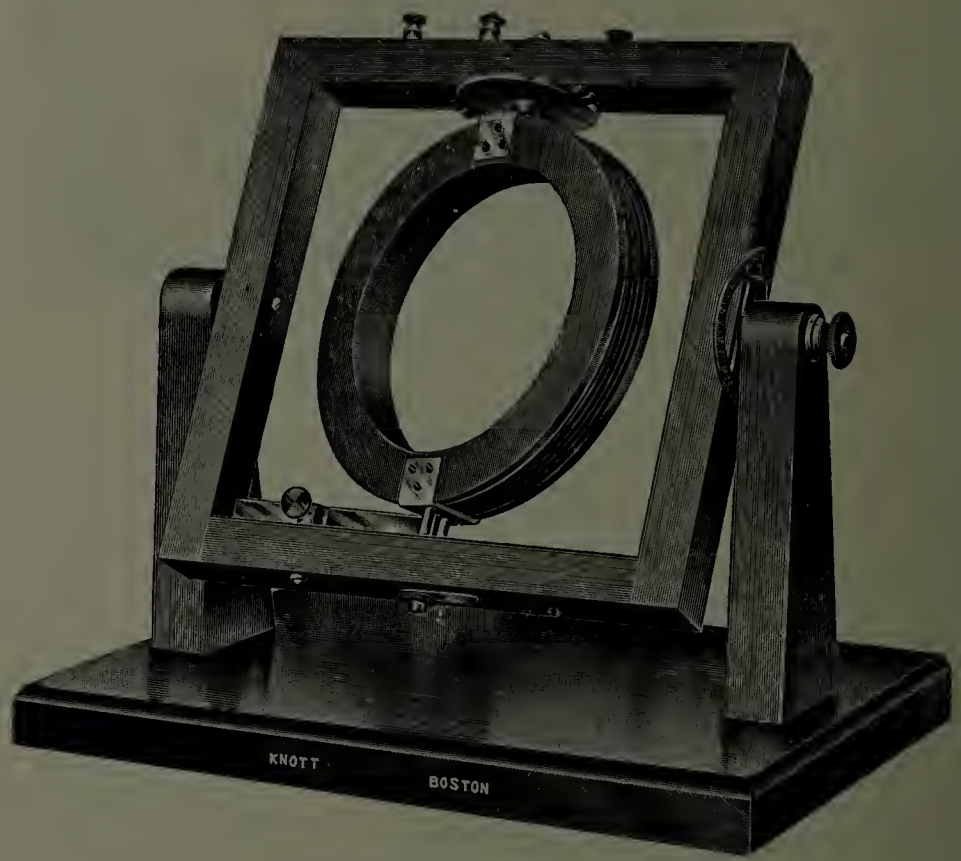
This is a high-grade instrument 5 inches in diameter. The moving system floating in alcohol is contained in a compensating chamber. It has a standard marine compass dial with line sights. The instrument is furnished in a neat mahogany case **11.50**

49–25 **SUN DIAL AND COMPASS.** This little instrument, 2 inches in diameter, combines features of both compass and sun dial. It is a pocket compass with raised dial with distinct divisions and figures, and agate center needle. As a sun dial, it is provided with distinct hour lines and may be readily set to any latitude. Case is nickel-plated and provided with hinged cover.

Duty Free **$6.75**

No. 49–25

UNIVERSAL INCLINATION EARTH INDUCTOR



No. 81–155

81–155 UNIVERSAL INCLINATION EARTH INDUCTOR for exact study of the magnetic moment of the earth's pole.

This improved design consists of a substantial base with uprights to which is swiveled a frame carrying a ring. The frame carrying the coil may be inclined to any angle within 180 degrees, the inclination being indicated by a pointer moving before a graduated arc. The ring has a groove in which are coiled about 1,000 turns double silk-covered wire. The leads of this wire are heavily insulated and the ends brought to binding posts shown on top of the frame. A positive throw is secured by a simple spring device shown at the bottom of the frame. This device, when set for use, is held by a projecting rod acting against the spring giving to it a tension. A release and stopping device, actuated by one button, gives to the ring a definite rotation through 180 degrees. This inductor is carefully made and must not be confused with those at a lower price on the market. Our mounting is of the most substantial construction, well finished, making the instrument not only of scientific value, but one in which any laboratory will take pride.

FEATURES:

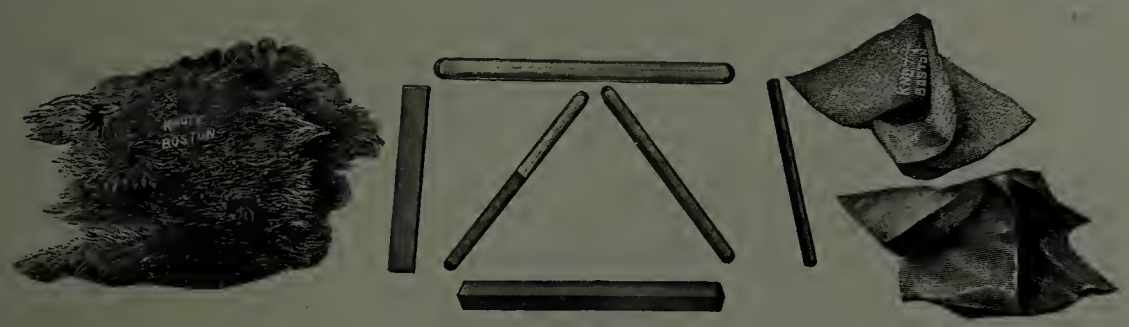
1. Universal inclination in two planes.
2. Gimbal mounting for varying the angle of inclination.
3. Graduated arc and pointer for easily determining the same.
4. Positive spring device for securing a definite rotation through 180 degrees.
5. A release and stopping device actuated by one button.

To facilitate in determining the constant of the instrument the B. & S. Gauge No. of wire, the inner and outer diameter of the coil, the number of turns in the coil and the resistance are all permanently recorded on the instrument **$19.50**

GENERATION OF STATIC ELECTRICITY

FRICTIONAL ELECTRICITY ACCESSORIES

In listing our line of Frictional Electricity Accessories, we desire to state that we use only the purest materials which, from our experimentation, have proved most satisfactory. Results, therefore, are assured.



Nos. 82–10 to 82–65

82–10 **AMBER SPECIMEN,** illustrating the power of amber in attracting light bodies, when rubbed with silk **$0.95**

82–15 **FRICTION ROD OF GLASS,** 12 × ½ inch, developing a positive charge when rubbed with silk, negative when rubbed with catskin or flannel . . . . . **.18**

82–20 **GLASS FRICTION ROD,** one-half ground, other half polished, developing both positive and negative charges regardless of the "rubber" . . . . . **.35**

82–25 **VULCANITE FRICTION ROD,** developing a negative charge when rubbed by catskin, flannel, or silk . . . . . **.38**

82–30 **WAX FRICTION ROD** (sealing wax), developing a negative charge when rubbed by catskin, flannel, or silk . . . . . **.10**

82–35 **CELLULOID STRIP,** 12 inches long, developing a negative charge when rubbed by catskin, flannel, or silk . . . . . **.18**

82–40 **FRICTION ROD, HALF GLASS, HALF BRASS,** illustrating rapid conduction of charge from a conductor . . . . . **.95**

82–50 **SILK EXCITING PAD** . . . . . **.40**

82–55 **FLANNEL EXCITING PAD** . . . . . **.25**

82–57 **FLANNEL CAP WITH ATTACHED SILK CORDS,** after Millikan and Gale, Figure 228 . . . **.15**

82–60 **CATSKIN,** small size, whole skin . . . . . **.75**

82–65 **CATSKIN,** large size, whole skin **1.25**

No. 82–75

82–75 **CHARGING ROD.** This charging rod has been designed in order to provide a simple and certain means for charging electroscopes. The charges are produced by the friction between a piece of flannel and a resinous rod. The whole is surrounded by a brass case which acts as a guide for the movable flannel ring. The rod can be used to produce either positive or negative charges **$6.50**

82–77 **THE IMPROVED POTENTIAL BAR.** This bar is designed to maintain a constant potential difference of 1,000 volts, mounted in form for convenient and satisfactory use with Electroscopes, Electrometers, Leyden Jars and other high potential electrical instruments. This is undoubtedly the most valuable single instrument obtainable for the study of electrostatic phenomena. Enables the instructor to carry on satisfactory lecture table demonstrations in static electricity regardless of atmospheric conditions **9.50**

ELECTROPHORUS

No. 82–110

No. 82–115

82–110 RITCHIE'S LECTURE TABLE ELECTROPHORUS for generation of static charges by the principle of influence. The plate of this electrophorus is 12 inches in diameter, constructed of a special high quality electro-static rubber mounted in a finished metal base. The disc is of heavy brass finely finished, provided with an insulating handle. It is handsomely finished throughout and built on a large plan so that it may be used to advantage on the lecture table **$9.25**

82–115 CAST-BASE ELECTROPHORUS. In this instrument, above illustrated, we secure a fine-quality instrument capable of striking results. The plate consists of a shallow trough casting in which is moulded a cake of resinous material. The disc is of heavy brass, provided with an insulating handle. The cast metal base insures insulating material against breaking **2.95**

GEAR DRIVEN INFLUENCE MACHINES

TOEPLER-HOLTZ — WIMSHURST

The demonstrator will be gratified to receive the announcement of the application of "gear drive" to influence machines. It is a fact generally recognized by all manufacturers of these machines that the simpler the machine, the better it is electrically, providing, of course, that the mechanism will hold the various parts in their proper positions during operation.

The greatest drawback to obtaining this result has been the "belt drive" with its recognized defects in slipping, breaking, slipping off the pulley, etc., etc., but which has been universally used because of its low cost of manufacture. In correcting this defect and to enable us to improve our product, as well as increase the efficiency electrically, we have selected the **self-contained gear drive** in which accurately cut gears operate in a case filled with heavy oil, — a form of construction which automobile manufacturers have brought to a high state of perfection. With this mechanism the power is applied at the same rigid support which holds the main axis of the machine. There is, therefore, no tendency to change the relation of the brushes, collectors and plates, as all are mounted on this same central shaft.

We announce **two types of Gear Drive Influence Machines** both of which have the same **important characteristics** which **will not be found on any other Influence Machine,** European or American.

On the following page we list the Toepler-Holtz Machines, on the second page following, the Wimshurst Machines.

FEATURES — DETAILS OF CONSTRUCTION

The following important features and details of construction will, we are confident, impress on the prospective purchaser the characteristic quality of **Knott's Gear-Drive Influence Machines.**

1. **GLASS PLATES** of a selected quality of toughened glass, chemically treated and coated with a special varnish which gives to the plates a durable, hard and smooth surface.
2. **COLLECTOR COMBS** are particularly efficient in collecting the plate charge with little loss. They are unusually long and sharp and, since centrally mounted, it is impossible for them to scrape against collector buttons.
3. **COLLECTING BRUSHES** will be found a decided innovation. The **Brush Holder** is of the spring clamp type, giving a positive contact and can be attached in an instant. Brushes are readily adjusted in these holders.
4. **POSITIVE GEAR DRIVE,** — accurately cut gears operate in heavy oil within the oil-tight gear casing.
5. **INSULATION, CONDENSERS** and other details of construction have been most carefully considered and all details combine to enable the demonstrator to secure a machine particularly well adapted to the most exacting requirements.

We wish once more to call to attention the unit method of mounting, by which all of the essential parts of the machine, together with the motive power, are attached directly to the rigidly constructed central support.

KNOTT'S GEAR DRIVE TOEPLER-HOLTZ MACHINES

No. 82–150

82-150 **KNOTT'S GEAR DRIVE TOEPLER-HOLTZ MACHINE,** 12 and 14-inch plates, gear movement in oil tight gear case, no belts to loosen or get out of order, brushes attached by spring contacts, repair bills reduced to a minimum. Spark one-third diameter of plate **$19.00**

82-160 **MULTIPLE PLATE GEAR DRIVE TOEPLER-HOLTZ MACHINE,** four plates 12 and 14 inches, gear driven. This machine has all the improvements detailed above.
The value of the multiple plate machine has long been recognized by the manufacturers of X-Ray apparatus, but the cost of construction has been such as to prohibit the general use in educational work. Our method of standardizing construction enables us to furnish this multiple plate machine at a cost within the range of laboratory work **32.50**

KNOTT'S WIMSHURST GEAR DRIVEN INFLUENCE MACHINES

This type of machine is especially recommended for localities where the humidity is frequently high, as it is much less affected by atmospheric conditions than any other type. The drive mechanism is substantially that of the Toepler-Holtz Machines described on the previous pages, except that the case is provided with another set of gears in order to give the revolution in two directions. The advantages of the gear drive in this type of machine are particularly noticeable since it does away entirely with the cross-belt and insures that both plates operate at the same speed, but in opposite directions. With the crossing and necessary slipping of belts, the belt drive cannot accomplish this result.

Our improved Gear Drive Wimshurst Machines, in addition to the most important manner of drive, has all mechanical features peculiar to our Influence Machines as described on page 291. Applied to the Wimshurst Machine, these features enable us to offer a machine considerably more efficient, of greater durability and more easily operated than has heretofore been offered.

82-215 **KNOTT'S FOURTEEN-INCH TWO-PLATE GEAR-DRIVE WIMSHURST INFLUENCE MACHINE,** glass plates chemically treated and varnished, mounted according to latest structural modifications and with gear drive, insuring a uniform speed of both plates in opposite directions. Spark length approximately 5 inches **$20.00**

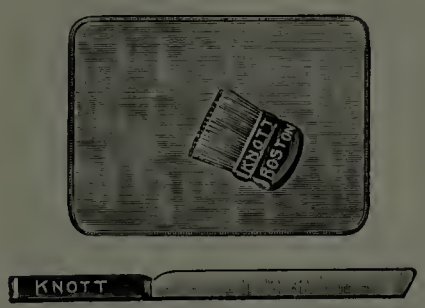
BELT-DRIVE RUBBER-PLATE WIMSHURST INFLUENCE MACHINE

No. 82-230

82-230 **EIGHT-INCH TWO-PLATE BELT-DRIVE WIMSHURST INFLUENCE MACHINE.** The low price at which this machine is offered prohibits the use of our enclosed gear drive. The belt drive will be found entirely satisfactory on a machine of this size. Spark length approximately 3 inches **$10.00**

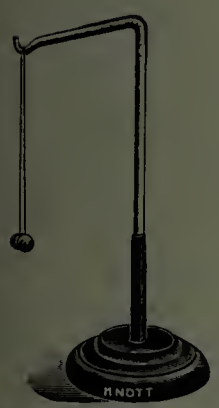
STATIC ELECTROMETERS

83–10	**PITH BALLS,** assorted plain and colored	Per Dozen	**$0.25**
83–12	**PITH BALL STATIC ELECTROMETER,** attached to silk cord, ready for use	Each	**.08**
83–15	**METALLIC COATED PITH BALL,** vastly more sensitive than the uncoated	Each	**.10**
83–17	**PITH BALL,** one-inch diameter	Each	**.60**
83–33	**GOLD-LEAF, PURE GOLD,** in book form for electroscope	Per Book	**.75**
83–35	**ALUMINUM-LEAF,** in neat, compact roll, especially prepared for electroscope work	Per Roll	**.35**
83–40	**TIN FOIL** for Leyden Jar coatings, Condensers, etc.	Per Pound	**1.25**



No. 83–50

83–50 GILDER'S KNIFE, PAD, AND TIP for cutting gold-leaf.
Frequent statements have been made us that it is almost impossible to replace broken leaf on electroscopes. This trouble arises, principally, from lack of proper tools. The outfit illustrated above will facilitate in the cutting and handling of even the finest gold-leaf.
Knife, Pad, and Tip, complete **$2.50**



No. 83-75

83–75 PITH BALL ELECTROSCOPE for qualitative demonstration of static charges.
This apparatus consists of a base on which is mounted an insulated support with arm. To this arm are suspended two pith balls, by fine silk fiber **$0.55**

83–100 PITH BALL ELECTROSCOPE, large size for lecture table demonstration. Two pith balls, 1 inch diameter, mounted as illustrated in No. **83–75** **2.25**

83–105 CHRISTIAN BROTHERS' ELECTROSCOPE. This simple instrument is in many respects superior to the ordinary electroscope. It is extremely sensitive and acts with readiness without the aid of drying agents. If desired, one part of it may be charged negatively and another positively, at the same time, and indications are readily observed by all members of the class.
It consists of an insulating stand on which is pivoted an ebonite needle of most approved size and shape for sensitive work. The only directions for care is that the needle should be dismounted when not in use and wrapped in brown paper so as to exclude light. By this means the needle is always in good condition, ready for instant use . . . . . **.80**

No. 83–105

No. 83–110

83–110 HARCOURT ELECTROSCOPE for demonstrating static charges, also illustrating an electric shield.
This apparatus consists of a metal plate in the center of which is placed a light mounted indicating needle. A metal screen with insulating handle is provided for placing over the plate. A second mounted needle is provided on top of the metal screen.
Upon the approach of a spark from a Static Machine or of any static charge it may be demonstrated that the upper needle is attracted or repelled while the lower remains unaffected **$1.75**

No. 83–135

No. 83–142

No. 83–150

83–135 **STUDENT'S ELECTROSCOPE,** simple flask form . . . . . $ 0.50

83–142 **CAST DRUM GOLD-LEAF PROJECTION ELECTROSCOPE** for use as an electrometer for general laboratory work, but especially adapted for use with a projection lantern. The glass front and back are mounted dust-proof, but may be readily removed. The brass rod carrying the gold-leaf strips is insulated with pure amber set in vulcanite. The spun metal cup (shown by dotted lines) which fits loosely over a collar on top of the drum, obstructs radioactive influences.
The general design and structure of this instrument are such that one is enabled to keep a charge for long periods of time. Under a ten days' test only a slight loss of initial charge was noted.
The ball top may be removed when it is desired to use the condenser plate attachment for demonstrating that the plates of a galvanic cell are statically charged.
Electroscope, complete with Plates and spun metal Protecting Cup 6.25

83–143 **CAST DRUM GOLD-LEAF PROJECTION ELECTROSCOPE,** without Condenser Plate Attachment, but with Protecting Cup 4.00

83–144 **CONDENSER PLATE ATTACHMENT** for use with No. **83–143** above, in demonstrating that the plates of a galvanic cell are statically charged. This attachment consists of two plates of polished brass, the lower in illustration to replace the metal ball, the upper with insulating handle. Plates with special dielectric 2.25

83–147 **FECHNER'S ELECTROMETER,** similar to above, but with the metal leaves adjusted between two highly polished metal plates. Complete with constant voltage Charging Box 11.50

83–148 ——, without Charging Box 9.00

83–150 **BENNETT'S GOLD LEAF ELECTROSCOPE WITH VOLTA'S CONDENSING PLATE AND SAUSSURE'S POINT DISCHARGE.** This instrument is intended for sensitive work in testing electrification of a body and in determining the polarity of the same. In our design we use the best quality of electrical glass and further increase the conducting quality of this glass by grounding it. The jar used is of special mould which allows of the use of the various attachments without disturbing the gold leaves. As a **Simple Gold Leaf Electroscope** the knob top alone is used. When it is desired to use the **Volta's Condensing Plates,** this knob is unscrewed and the bottom plate put in its place. Differing from the usual method of securing a condensing surface on these plates, we furnish with each instrument a special dielectric which greatly increases the condensing power. The bottom plate is replaced by the **Saussure Point Discharge** when it is desired to test the effects of points in discharging electricity from the surface of a conductor.
This electroscope is of heavy construction and is handsomely finished throughout. It is furnished complete with interchangeable knob, Volta's Condenser Plates, one with insulating handle, and with Saussure's Point Discharge 8.75

THE WILSON RADIO-ELECTROSCOPE

DESIGNED FOR RESEARCH WORK IN RADIO-ACTIVITY

83–165 THE WILSON RADIO-ELECTROSCOPE. This instrument, which was originally manufactured at the request of the Department of Physics of the University of Toronto, instantly met with much favor among all workers in the radio-active field and has for several years been considered standard for high-grade work.

As the illustration shows, the instrument is especially designed for telescope reading, a special telescope with cross-hair mounting having been designed for the exact measurement of the angular movement of the gold leaf. The form is such that it also lends itself perfectly to lantern projection.

INSULATION. The insulation is as perfect as the purest amber can make it, it having remained charged for 48 hours with no fall capable of being detected with telescope reading.

SELF LEVELING. Owing to the method of supporting the gold leaf member, no care is required in leveling, the gimbal bearing making it perfectly automatic.

No. 83–165

METHOD OF USING THE RADIO-ACTIVE MATERIAL. The opening in the base pillar, seen in the illustration, is designed for the ready inserting of the material to be tested. In use, this material is placed in a small watch glass and inserted in the opening, the outside collar then being moved up to exclude all air currents and to keep the conditions within the instrument as nearly uniform as possible. The distance between the radio-active material and the gold leaf is variable and easily determined by the number of discs seen in the illustration, which are placed under the watch glass, thus fixing definitely the distance between the radio-active material and the gold leaf. It will thus be seen that all conditions have been carefully considered and provided for.

Price, complete $13.50

No. 83–170

83–170 MOUNTED TELESCOPE FOR RADIO-ACTIVE WORK. This telescope has been designed for rapid and exact measurement of the angular drop of the gold leaf due to the gradual loss of potential under the influence of the radio-active material. A four-inch graduated dial is mounted on the eye-piece of a reading telescope in such a manner that the dial, eye-piece and cross-hair move as a rigid unit. The angular movement of the cross-hair is therefore easily read by the dial and pointer.

In use, the eye-piece is rotated until the cross-hair is parallel to the deflected gold leaf. Note the reading on the dial in degrees. After the lapse of a single unit of time, the dial is to be turned again until the cross-hair is again parallel to the gold leaf. The difference in readings on the scale denotes the angular fall.

Price for telescope with mountings complete, as illustrated, for radio-active work 16.25

RADIO-ACTIVE ELEMENTS. See No. 83–275

No. 83–220

83–220 THE RAYBOURN QUADRANT ELECTROMETER, designed to meet the requirements of a universal instrument. By means of the telescoping suspension tube we are able to use any desired length and type of suspension so as to adjust the sensibility of the instrument, within limits, to any desired sensibility.

As carried in stock it is supplied with a 50-centimeter phosphor bronze suspension ribbon which, while it is extremely durable, will give ample sensibility for most purposes.

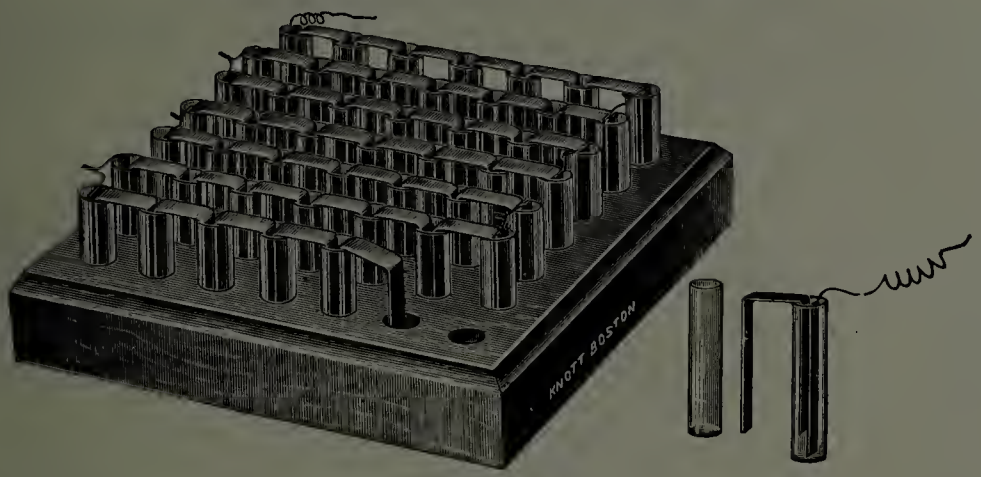
DISTINCTIVE FEATURES.

1. A quadrant box of open construction affording easy access and view of the needle.
2. A needle of very light weight, aluminum welded to the axis wire of copper, the upper end of which is bent to form a hook for attaching suspensions. This construction greatly lessens the surface resistance of the metal, which, in case of an aluminum hook ordinarily used, is very great.
3. A space beneath the quadrants is ample for placing drying material.
4. A very light weight optically plane mirror.
5. Pure amber insulation throughout.
6. A zero adjustment, simple but most effective and impossible of accidental derangement.
7. A removable metal protecting case with large rectangular opening covered by a window of uniformly thin flat glass.
8. Mounted on tripod and held to same by a friction clamp which permits of a rotary movement of the electrometer.
9. Binding posts and links permit grounding of case or either pair of quadrants.
10. Suspensions may be readily attached.
11. A telescoping support allows suspensions of any desired lengths within range of from 30 to 50 centimeters.
12. Inasmuch as degree of sensibility required depends upon the nature of the work, we supply our stock instruments with a metallic suspension 50 centimeters long. These suspensions will be found very durable and sufficiently sensitive for all work except where extreme sensibility is required, in which case we are prepared to furnish other types of suspensions.

We confidently recommend this instrument for all classes of work where an electrometer of superior sensitiveness and quality is required **$39.50**

83–222 CONSTANT VOLTAGE CHARGING BOX, — designed for the easy and convenient charging of Electroscopes and Electrometers, maintaining a constant difference of electrical potential of 250 volts **2.50**

ELECTROSCOPIC ACCESSORIES



No. 83–250

83–250 WATER BATTERY. For charging the needles of electrometers and for gauging electroscopes, a battery giving real, constant and well-defined electromotive forces is essential.
It has 50 cells, mounted on substantial, neatly finished wooden base and is particularly adapted to advanced work when high voltage and low amperage are desired. It will be found a most serviceable battery for all electrostatic electrometer work **$6.25**

83–252 ——, same as above, but comprising 100 cells. This battery is a combination of two of the above **12.75**

No. 84–10

No. 84–15

82–75 CHARGING ROD for securing either positive or negative charges for electroscopes. For description, see page 289 . . . . . **$6.50**

82–77 THE IMPROVED POTENTIAL BAR. This bar is designed to maintain a constant potential difference of 1000 volts, mounted in form for convenient and satisfactory use with Electroscopes, Electrometers, Leyden Jars and other high potential electrical instruments. This is undoubtedly the most valuable single instrument obtainable for the study of electrostatic phenomena **9.50**

83–275 RADIO-ACTIVE SUBSTANCES. For the convenience of those who desire to make a study of radio-activities we list four of the most important substances. They are black uranium oxide, pitch-blende, thorium nitrate and uranium nitrate.
Set of four in sealed glass stoppered bottles **3.50**

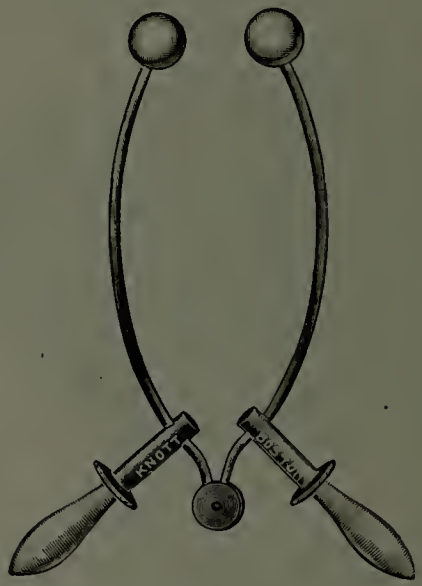
INSULATION AND CONDENSATION OF STATIC ELECTRICITY

84–10 INSULATING STOOL, valuable in insuring total insulation from the earth.
This stool is constructed with a handsomely finished hardwood top, provided with four glazed porcelain legs with knob feet, the insulating qualities of which are unexcelled, even by glass . . . **2.50**

84–15 ADJUSTABLE INSULATING STAND, solid in construction, insulating qualities sufficient for all practical purposes.
Consists of a supporting plate held adjustably by two vulcanite rods to a metal base.
Complete as illustrated **2.50**

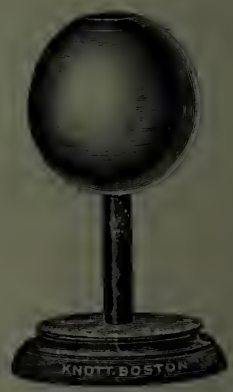
No. 84–20

No. 84–25



No. 84–30

No. 84–40



Nos. 84–50 to 84–55

84–20 PROOF-PLANE, simple disc type with insulating handle $0.22

84–25 GUARDED DISCHARGER, simple form, polished brass arc with ball terminals attached to a polished ebonite handle with disc ebonite guard 1.25

84–30 TWO-HANDLED JOINTED DISCHARGER, two highly polished brass arcs with knob terminals, jointed to provide an adjustable gap, each arc with insulating handle of ebonite 2.75

84–224 DISCHARGER, lighter construction than above, ordinary grade 66

84–40 SHOCKING HANDLES AND CORDS, the standard form used in testing physiological effects of electrical discharges. Two nickel-plated metallic handles, one with insulated carrier; two conducting cords, each cord with connector tips. Per pair with cords 1.00

No. 84–60

84–50 SIX-INCH INDUCTION AND DISTRIBUTION SPHERE for showing that a charge remains on the outer surface and does not penetrate into the interior.

This sphere is made of spun brass, highly polished, having a hole in the top. It is mounted on a neat, brightly japanned base with an insulating ebonite pillar. Diameter 6 inches 5.00

84–55 FOUR AND ONE-HALF INCH INDUCTION AND DISTRIBUTION SPHERE, same as above but 4½ inches in diameter 2.75

84–57 INDUCTION SPHERES, brass, nickel-plated, 5 centimeters diameter. Mounted on insulating supports so that they can be brought in contact . .Per pair 3.30

84–60 SIXTEEN-INCH INDUCTION CYLINDER for illustrating electrostatic induction.

This apparatus consists of a polished brass cylinder, 16 inches in length, mounted on an insulated support with tripod base. This cylinder is provided with movable brass supporting arms to which are attached pith balls.

If a positively charged sphere be brought near one end of the cylinder, that end will become negatively charged while the opposite end will be positive 7.80

84–65 EIGHT-INCH INDUCTION CYLINDER, similar to above, but 8 inches long 3.50

No. 84–70

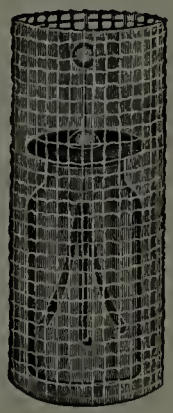
84–70 HOLLOW INDUCTION CYLINDER for demonstrating that a charge collects on the surface only.

This apparatus consists of a polished brass tube supported on an ebonite stem attached to a base. It is provided with a support for pith balls, both within and without the cylinder. When charged, pith balls without the cylinder will fly apart, while those within will remain unmoved, demonstrating that the outside only is charged $1.95

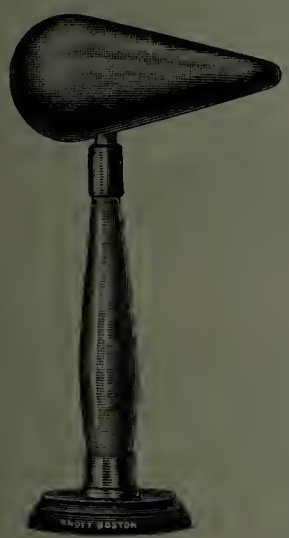
84–75 FARADAY'S METAL SHIELD or ELECTRIC SCREEN for covering electroscopes, illustrating the Marconi system of selecting electric signal waves; also illustrating the principle of protection from lightning.

Mount an electroscope on a metal plate placed on a stand or on the table top. Place Screen over electroscope. Allow sparks from a Static Machine to reach the Screen and note leaves of electroscope. Remove screen and metal plate and test leaves by merely approaching a charge to the electroscope.

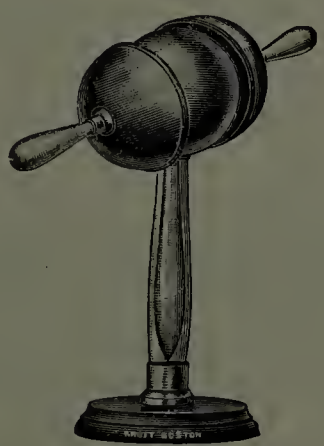
Metal Shield only 45



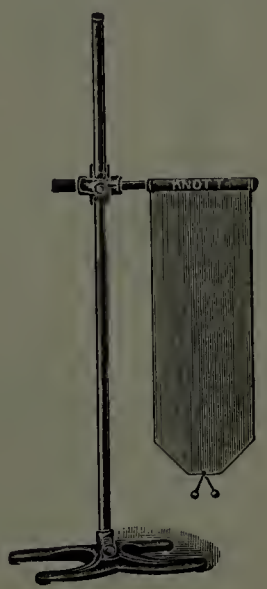
No. 84–75



No. 84–80



No. 84–86



No. 84–90

84–80 ELLIPSOIDAL CONDUCTOR for demonstrating the tendency of static distribution.

This design consists of a polished brass ellipsoidal body mounted on an insulated stem with a neatly finished base. Size of ellipsoid, 8½ inches long, 3½ inches in diameter $4.50

84–85 BIOT'S HEMISPHERES for demonstrating that a static charge seeks the outer surface of a body.

This apparatus consists of two polished brass hemispheres with insulating handles. These hemispheres are designed to fit over No. **84–55** Induction and Distribution Sphere.

When the globe is electrified and two hemispheres are placed over it, and then removed, it will be found that they have become electrified while the globe has lost its charge.

Biot's Hemispheres, only 2.25

84–86 BIOT'S HEMISPHERES and NO. 84–55 INDUCTION AND DISTRIBUTION SPHERE, complete as illustrated 5.00

84–90 RITCHIE'S SURFACE AND INTENSITY APPARATUS for showing the variation of electrical density on a unit of surface as that surface is diminished or increased.

This ingenious instructive instrument consists of a special clamp in which fits the roller insulated from the clamp. Around this roller is wound tin foil. An electrometer in metallic contact with the tin foil indicates the quantity of electrical force.

When the tin foil is rolled up, a charge is imparted to it by which a certain divergence is produced on the balls of the electrometer. On unrolling the tin foil this divergence gradually diminishes but increases as it is rolled up again.

The clamp of this instrument may be attached to any 19-millimeter rod.

Without supporting stand 3.80

No. 84–100

No. 84–125

84–100 FARADAY'S CONICAL NET. A net 11 inches long by 5 inches diameter on insulating mount for demonstrating that a static charge will always reside on the outside. The apparatus consists of a conical bag of linen gauze, supported on an insulating stand and to which are attached silk strings by which it may be turned inside out.

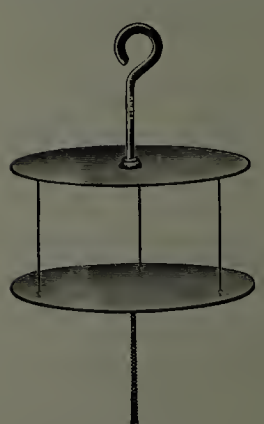
In use, this conical bag is charged, which, by tests, may be shown to reside on the outside only. When pulled inside out, and tested, it will be found that the charge still is on the outside, having passed through the gauze **$1.65**

84–125 BELL CHIMES, illustrating electrostatic attraction and repulsion between electrified bodies.

This apparatus consists of an insulated stand to the top of which are attached three cross-heads, to the ends of each of which are attached bells suspended by brass chains. The lengths of these chains are adjusted so that all six will be in the same plane as a large bell mounted to the insulating support. Also mounted to these cross-heads are six silk cords each holding a small metal ball. The lengths of these cords are adjusted so that the balls will lie in the same plane as the bells.

When this apparatus is electrified, the small balls will be attracted and repelled between the large bell and the small bells, causing a continuous jingle **9.00**

84–130 UNMOUNTED BELL CHIMES, ordinary type . . . . . **.90**



No. 84–155

84–155 IMAGE PLATES for illustrating the phenomenon of attraction and repulsion.

This apparatus consists of two nickel-plated discs suspended one to the other by insulating cords. To the upper disc is fastened a nickel-plated hook for attaching to the Static Machine; the lower is provided with a chain for securing connection with the ground or opposite pole of Static Machine.

In use the pith images are placed between the two plates. They will dance up and down as they become charged with positive and negative electricity **1.80**

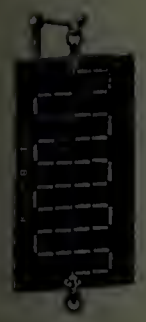
84–157 PITH IMAGES, a pair of images constructed of pith for use with No. **84–155** Image Plates . . . . . Per Pair **.40**

84–175 POLE-TEST PAPER. When two electrical leads are placed close together upon a moistened strip of this paper, the negative pole may be distinguished by the pinkish stain which it leaves . . Per Sheet **.05**

ELECTROSTATIC PHENOMENA

The following accessories will be found interesting for lecture work. With even the smallest size Influence Machine, a great variety of interesting experiments may be performed. The workmanship of each accessory is accurate and under proper conditions the desired phenomena may be strikingly illustrated.

As each accessory is designed to fit our No. **84–200** Universal Stand, only one stand will be found necessary.


No. 84–212

No. 84–206

No. 84–214

No. 84–204

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No. 84–222

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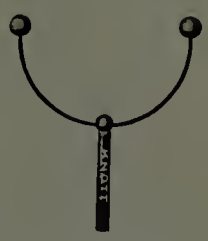
No. 84–208

No. 84–200

No. 84–220

No. 84–218


No. 84–224

84–200 **UNIVERSAL STAND.** May be used with all accessories listed . . . . . **$ 1.00**

84–202 **PAPER BRUSH.** When discharged, paper strips will stand out as illustrated . . . . . **.55**

84–204 **BELL CHIMES,** consisting of five harmonically tuned bells which, when connected to Influence Machine, will cause small balls to rapidly vibrate back and forth between them **2.60**

84–206 **DANCING BALLS AND HOLDER.** Apparatus connected, the balls will dance within the holder **2.70**

84–208 **WHIRL.** When connected to Influence Machine, charge will leap rapidly from points, causing a rotary motion . . . . . **.70**

No. 84–230

84–210 **HOLDER FOR GEISSLER TUBE AND LIGHTNING PLATE** . . . . . **.50**

84–212 **EBONITE LIGHTNING PLATE.** Spectacular sparks across gaps in tin foil when connected with Influence Machine **1.20**

84–214 **LIGHTNING SPIRAL TUBE.** Spectacular spiral of sparks across gaps in tin foil when connected with Influence Machine **1.60**

84–216 **BALL RACE.** Hollow glass sphere will race rapidly around track when connected to Influence Machine **1.65**

84–218 **SMOKE CONDENSATION APPARATUS.** The smoke from a smoke handle within a glass holder is condensed when connected to an Influence Machine, entirely disappearing **2.70**

84–220 **SHOCKING HANDLES** for electrifying persons . **.60**

84–222 **LEYDEN JAR,** best glass, heavy tin foil covering, 4 inches high **1.10**

84–224 **DISCHARGER** . . . . . **.66**

84–226 **CONDUCTOR CHAINS** for connecting accessories to Influence Machine . . . . . **.25**

84–230 **DEMONSTRATION SET** for illustrating electrostatical phenomena. For the convenience of those who desire to order a complete set, we furnish the set as listed above, Nos. **84–200** to **84–226,** enclosed in a strongly constructed cardboard box divided into compartments **16.50**

SUPPLEMENTARY DESIGNS

ELECTROSTATIC PHENOMENA

No. 84–240

No. 84–244

No. 84–248

No. 84–246

No. 84–242

No. 84–250

No. 84–252

No. 84–254

No. 84–256

No. 84–258

No. 84–260

84–240 **ELECTROSTATIC MOTOR;** the ebonite spider with the metallic balls is rotated rapidly when connected to an Influence Machine **$5.25**

84–242 **GLASS PENETRATING APPARATUS** for producing breath pictures and for penetrating glass. When connected to an Influence Machine, the imprint of a coin will be invisible until the glass is breathed upon. With this apparatus, also, a glass plate ⅛ inch in thickness will be penetrated by a spark even from the smallest Influence Machine **3.15**

84–244 **SAND APPARATUS.** Fine glass sand placed in the funnel will emerge through the hole in the bottom in the form of a straight stream. When funnel is electrified, the sand grains will repel each other, causing the stream to spread out and the fine grains will fall with a spattering noise . **1.95**

84–246 **QUADRANT ELECTROMETER.** When not charged, the ball will lie against the metallic rod. When charged, the ball will be repelled and according to the strength of the machine to which it is connected, will show a large or small deflection **2.35**

84–248 **ELECTRIC MORTAR.** When connected with an Influence Machine, a spark will jump across the inside of the mortar. The air is suddenly expanded and the ball lying loose on the top is thrown up into the air. If a Leyden Jar is also connected, there will be an explosion and the ball will fly a considerable distance **1.35**

84–250 **BEETZ' ELECTROSCOPE** for demonstrating that a charge collects on the surface only. When apparatus is electrified, the two balls at the top will fly apart while those within the cylinder will show no movement **1.65**

84–252 **CANDLE EXPERIMENT** for demonstrating that negative electricity will repel a flame and that positive will attract. This apparatus will also show the so-called electric wind, which may be so strong that, when in proper position, the candle is extinguished. An extra ball with a point is supplied to replace one of the balls with hook on the ebonite collar. In performing this experiment, both balls with hooks must be removed from the pillars **1.95**

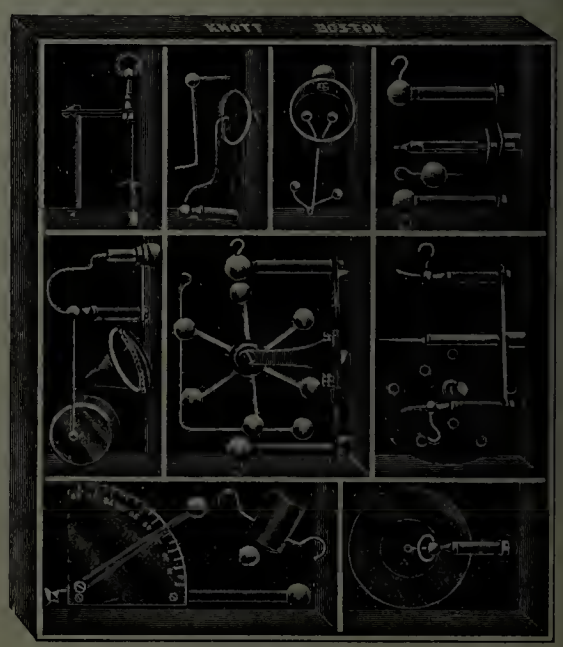
84–254 **REVOLVING DISC.** The ebonite disc which is studded with small colored circles for obtaining a better visibility is made to revolve rapidly in consequence of the radiation of the electricity from the points beneath it . . . **$2.00**

84–256 **RADIATION APPARATUS.** After the apparatus has been connected to the Influence Machine, a luminous circle will be seen in the dark radiating from the disc to the ring . . **1.95**

84–258 **LIGHTNING CONDUCTOR.** A small quantity of benzine or ether is placed in the small dish. The point resembling a lightning conductor is unscrewed from the knob mounted on the ebonite pillar. If a spark is now caused to strike this knob, the contents of the dish will be ignited. If point is replaced and grounded by a chain and experiment repeated, there will be no ignition as the spark will be slowly discharged through the point . **2.35**

84–260 **IGNITION APPARATUS.** By means of a spark from a Leyden Jar, small pieces of ignition paper are ignited. With extra supply of ignition paper **1.75**

84–265 **SUPPLEMENTARY DEMONSTRATION SET,** consisting of Nos. **84–240** to **84–260** together in a strongly constructed wood-reinforced cardboard box, divided into compartments **19.75**

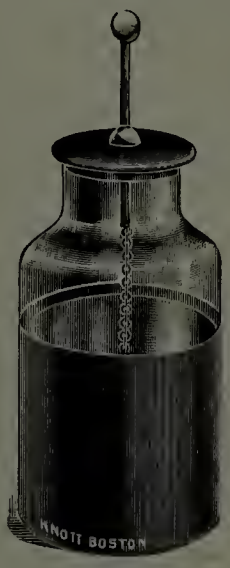


No. 84–265

STORAGE OF STATIC ELECTRICITY

No. 85–10

No. 85–15



No. 85–20

No. 85–40

85–10 DEMONSTRATION LEYDEN JAR for demonstrating that an electric charge resides as potential energy in the glass of a Leyden Jar and not in the metallic coatings.
This is a dissectible Leyden Jar, the outer metallic covering being removable as well as the inner. The inner is provided with a rod with ball terminal for charging. This form must not be confused with the many types on the market. We use a special form of toughened glass for our glass jar and our coatings are of polished brass. The instrument presents a handsome appearance and readily recommends itself in comparison with other makes **$2.90**

85–15 QUART LEYDEN JAR for storing static electricity.
This jar is constructed of a special quality of toughened glass, the coatings being smoothly applied. Provided with insulating cover through which passes a rod, one end of which is terminated in a knob. To the other is attached a chain making connection with the inner coating **1.60**

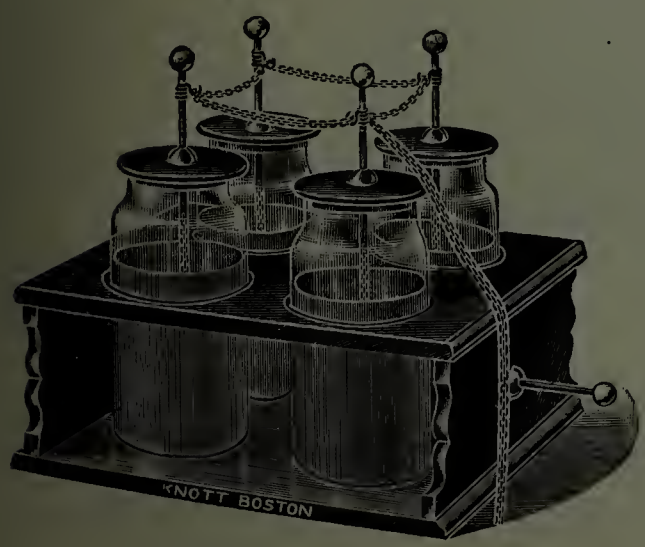
85–20 TWO-QUART LEYDEN JAR, same quality as above **2.00**

85–25 LEYDEN JAR, as used on our 12-inch Toepler-Holtz Influence Machines **1.00**

85–30 LEYDEN JAR, as used on our 16-inch Toepler-Holtz Influence Machines **1.10**

85–40 LUMINOUS LEYDEN JAR for demonstrating optically the distribution of static electricity over the surface of a condenser being charged and discharged.
This jar is of the same size as our No. **85–20,** but is coated inside and out with a tin-foil coating which is not continuous but cut diamond-shaped **3.15**

LEYDEN JAR BATTERIES



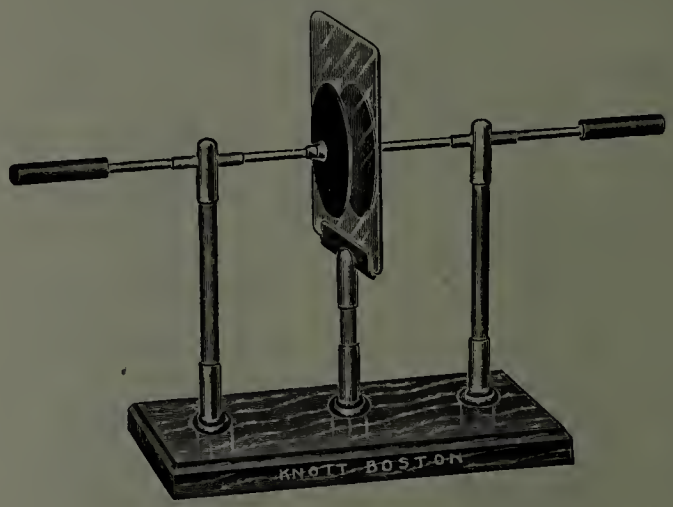
No. 85–65

These consist of a series of Leyden Jars as previously listed, arranged so that their inner coatings are connected to one terminal and their outer coatings to another, thus securing a larger area of coated surface than is contained in one jar. With an arrangement, therefore, of more than one jar connected in this manner it can be demonstrated that the capacity of a condenser is directly proportional to the area of its coated surface. This will be demonstrated by the greater time it takes to charge the battery and the more powerful spark obtained.

In the form of battery above illustrated we furnish one in which all connections are open to view. The jars are made of the same high quality of di-electric glass as used in all our Leyden Jars. They are placed in a box lined with heavy tin foil which serves to connect the outer coatings with the jars. The inner coatings are connected by means of brass chain.

85–60 TWO-JAR LEYDEN BATTERY . . . . $ 6.80
85–65 FOUR-JAR LEYDEN BATTERY . . . 11.70
85–70 SIX-JAR LEYDEN BATTERY 16.00

PLATE CONDENSERS

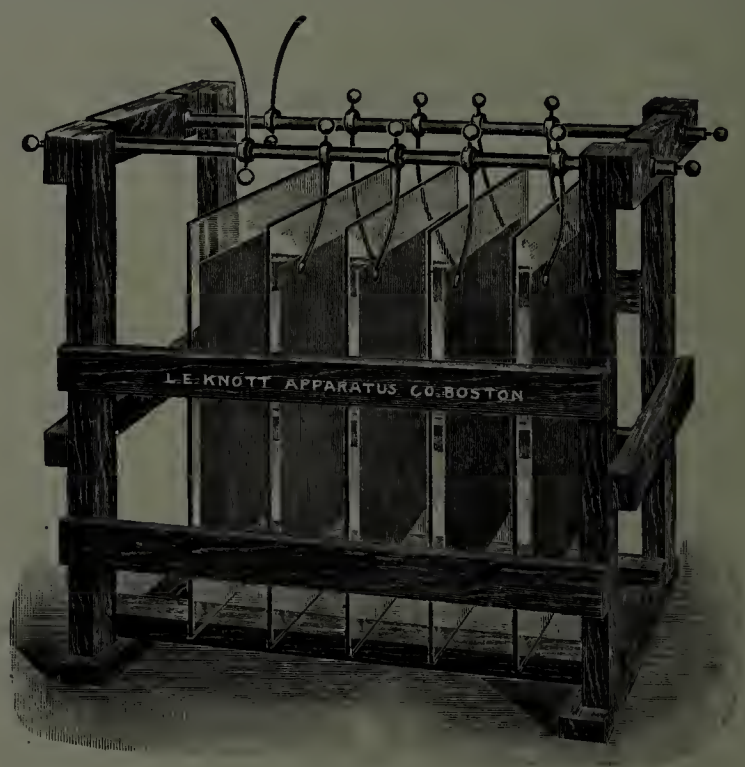


No. 85–100

85–100 **DISSECTIBLE DEMONSTRATION PLATE CONDENSER** for a study of induction in a condenser. This apparatus consists of a neatly finished wooden base on which are mounted three insulating uprights. On the central upright is mounted a glass plate, on each of the others a rod sliding in a hole at the top of the upright. Each rod carries at one end a brass plate, at the other an insulating handle. All parts are carefully assembled and metal work polished and lacquered.

By means of a suitable electrometer the density and distribution of a charge under various conditions may be readily determined **$9.60**

85–105 **MOUNTED CONDENSER PLATES,** after Millikan, Gale and Bishop (Experiment 27) . . Pair **.25**



No. 85–110

85–110 **MOUNTED GLASS PLATE CONDENSER** for use as a Leyden Jar Battery in accumulating and storing static charges.

This condenser consists of a neatly finished hardwood frame in which are mounted five condenser plates constructed of the best quality toughened glass and having a total condensing surface area of 1,620 square centimeters. Two parallel conductor rods mounted at the top of the frame over the plates and provided with contact arms for connecting any number of plates desired up to five serve to charge the condenser.

Complete as illustrated **$14.50**

ELECTRICAL DISCHARGE TUBES

GEISSLER TUBES

Our collection of **GEISSLER TUBES** has been selected with the greatest care, the basis of selection being that of the greatest color effects with didactic illustrative features. These tubes are manufactured by one of the most prominent manufacturers in Europe whose name is a sufficient guarantee of quality. Each tube is provided with strong terminals sealed securely in a manner to obviate frequent breakages at terminal points.

These tubes are constructed of uranium and white glass formed into various shapes for producing pleasing optical effects. The air is then evacuated and the tubes are sealed.

No. 86–10

86–10	**GEISSLER TUBES,** plain, set of six different shapes, 6 inches (15 centimeters) long, enclosed in neat cardboard case		**$3.00**
86–11	——, same as above	Each	**.50**
86–15	**GEISSLER TUBES,** similar to above, but more complicated in form, presenting more pleasing effects, set of six, 12 inches (30 centimeters) long, in neat cardboard case		**5.70**
86–16	——, same tubes as contained in above set	Each	**.95**

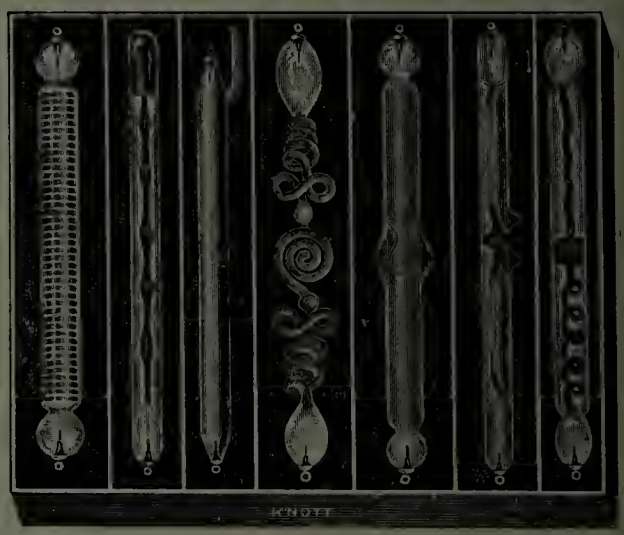
No. 86–25

86–25	**FLUORESCENT GEISSLER TUBES.** These tubes are constructed in a manner similar to above, but filled with fluorescent liquids such as eosine, quinine, kerosene, æsculine, and uranine. These tubes present very handsome colors and are highly recommended. Set of six, 6 inches (15 centimeters) long, enclosed in neat cardboard case		**$5.40**
86–26	——, same tubes as contained in above set	Each	**.90**
86–30	**FLUORESCENT GEISSLER TUBES,** similar to above, but more complex in form. Length 12 inches (30 centimeters). Set of six in neat cardboard case		**9.90**
86–31	——, same tubes as contained in above set	Each	**1.65**

86–40 FOURTEEN-INCH LECTURE TABLE GEISSLER TUBES. These tubes are designed to illustrate the principal types of Geissler tubes. They are 14 inches (35 centimeters) long and give remarkably beautiful results. Set of seven tubes as follows:

(1) Double Tube, containing two fluorescent liquids.
(2) Double Tube, containing two phosphorescent substances.
(3) Highly Evacuated Tube, constructed of uranium and white glass.
(4) Double Tube, containing two gases.
(5) Mercury Tube. Will show phosphorescence by shaking mercury in the tube.
(6) Tube containing a mercury salt which changes colors as heated.
(7) Tube showing layers of light.

Set complete, in neat cardboard case $14.80



No. 86–40

86–45 FLUORESCENT GEISSLER TUBE, containing two fluorescent liquids, illustrating fluorescence of different colored liquids 2.35

86–46 PHOSPHORESCENT GEISSLER TUBE, containing two phosphorescent substances $2.10

86–47 GEISSLER TUBE, constructed of uranium and white glass, highly evacuated, to illustrate colors through different qualities of glass 2.00

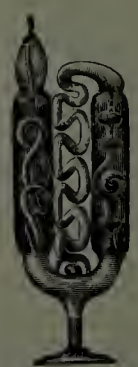
86–48 GEISSLER TUBE, containing two different gases 2.00

86–49 PHOSPHORESCENT MERCURY TUBE. This tube does not require use of Influence Machine or Induction Coil, as phosphorescence of the mercury may be shown by simply shaking it from one end of the tube to the other 2.60

86–50 PHOSPHORESCENT GEISSLER TUBE, containing a mercury salt which exhibits different colors as it is heated 2.10

86–51 GEISSLER TUBE, constructed to show various strata of light 2.00

No. 86–60


No. 86–62

No. 86–64

No. 86–66

86–60 GEISSLER TUBE, improved form, constructed of uranium and white glass and filled with various fluorescent liquids, mounted on glass foot, and provided with strengthened terminals for connection to Influence Machine or Induction Coil. Height 6 inches $1.65

86–62 GEISSLER TUBE, improved form, as above, but of different shape and more complicated design. Height 6 inches (15 centimeters) 1.75

86–64 GEISSLER TUBE, similar to above, but more complicated design, height 6 inches (15 centimeters) 1.95

86–66 GEISSLER TUBE. The design illustrated excels in colors. It is designed to show fluorescence of three different colored liquids and two gases, as well as the colors of uranium and white glass. It is mounted on glass foot and is 6 inches (15 centimeters) high 2.25

No. 86–75

86–75 UNEQUALLY EVACUATED GEISSLER TUBES for showing effects upon a spark as it passes through tubes filled with unequally attenuated air.

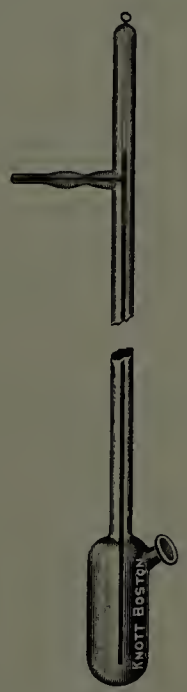
This apparatus consists of five connected Geissler Tubes, each of which has a different degree of exhaustion.

In the least exhausted tube the spark is well defined, but as the vacuum increases, this spark begins to widen out and fill the whole tube, becoming pale in tint and nebulous in form . . . . . Per set of five **$8.90**

86–85 EXPERIMENTAL BAROMETER VACUUM AND GEISSLER TUBE. The tube illustrated is designed for the purpose of making a critical study of the vacuum in a barometer tube, Geissler tube, Crooke's tube and X-Ray tube.

Platinum electrodes are inserted in both the upper and lower end of the tube. The mercury reservoir holds sufficient mercury to fill the entire chamber. The length of the tube is such as to allow ample vacuum space above the mercury under complete exhaustion. The air is exhausted through the tubulature at the top of the tube, while the reservoir is filled through the tubulature in the base.

For the study of the barometer, the Cooper-Hewitt Lamp, the Geissler tube, the Crooke's tube, the X-Ray tube and all electrical phenomena under reduced atmospheric pressure, we consider this the most important piece of apparatus that has ever been offered **3.25**



No. 86–85

GEISSLER TUBE ROTATORS

No. 86–100

86–100 GEISSLER TUBE ROTATOR for rotating Geissler Tubes to increase the spectacular effect.

Our Rotator consists of a practical motor (not a toy) constructed after designs of the expensive commercial types. It is mounted upon a substantial metal pedestal support and is provided with appropriate binding posts, one pair for battery or other current and one pair for induction coil or Influence Machine. The Geissler tube is attached to the holder, which may be firmly fixed to the spindle of the rotator. This holder is adjustable to take any Geissler tube up to 12 inches in length.

Motor only, with Geissler tube attachment, motor wound for battery current **$12.00**

86–102 ——, same as above, but motor wound for 110 volts, D. C. **13.25**

86–104 ——, same as above, but motor wound for 110 volts, A. C. **13.25**

86–110 GEISSLER TUBE HOLDER for use with our No. **21-10** Mechanical Rotator or our No. **21–30** Motor Rotator, to hold Geissler Tubes for rotation.

This holder can be firmly attached to the spindle of either of these rotators and is adjustable to hold all sizes of Geissler tubes up to 12 inches long **2.70**

SPECTRUM AND VACUUM TUBES

Nos. 77–225 to 77–236

No. 77–245

77–225 **GEISSLER SPECTRUM TUBE,** most careful construction, filled with carbon dioxide **$1.95**

77–226 ——, filled with hydrogen gas **1.95**

77–227 ——, filled with nitrogen gas **1.95**

77–228 ——, filled with oxygen gas **1.95**

77–235 **GEISSLER SPECTRUM TUBE,** most carefully constructed, evacuated, and filled with pure argon gas **7.75**

77–236 ——, same as above, but filled with helium **7.75**

77–245 **GEISSLER SPECTRUM TUBE** for evacuating and filling with whatever gas desired. Fitted with two carefully ground glass cocks **1.95**

86–150 **DE LA RIVES APPARATUS** for showing that magnets act on light in Geissler tubes in accordance with the laws with which they act on any other movable conductor.

The apparatus consists of a highly evacuated bulb sealed into the lower end of which, and extending up into the bulb, is a tube, into which extends a rod of soft iron. This rod, in use, is magnetized by an electro-magnet.

Terminals of the bulb are connected to an electrostatic current or current from an induction coil, and a beam of light passes from one terminal to the other. When the voltaic current is turned through the electro-magnet, this beam of light turns slowly about the magnetized rod, sometimes in one direction, sometimes in the other, according to the direction of the induced current or of the induced magnetism.

Complete with electro-magnet **$5.90**

No. 86–150

No. 86–160

No. 86–165

No. 86–170

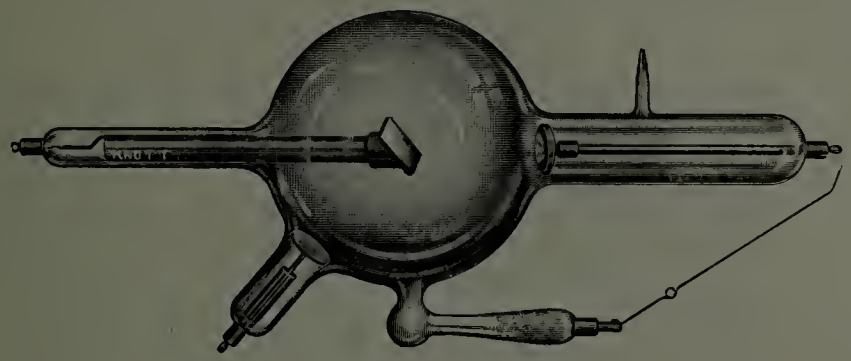
86–160 **VACUUM TUBE** for showing the heating effect of the cathode ray. The negative electrode is in the form of a mirror, designed to focus the cathode ray upon a piece of platinum foil, heating it white hot in a very short time **$7.75**

86–165 **VACUUM TUBE** for showing the deflection of a cathode ray. On one side of an evacuated tube is a fluorescent screen with a strip with slit at right angles. This strip absorbs the cathode rays except those which pass through the slit. By holding a magnet to the tube, it may be shown that this beam is deflected as indicated by its path on the fluorescent screen **6.50**

86–170 **VACUUM TUBE** for showing the power of a body to interpose the cathode ray. When the discharge passes, the cathode rays proceed in straight lines. The small cross, however, interposes a number of these molecules and a shadow of the cross is cast on the opposite side of the tube . . . **7.25**

ROENTGEN RAY APPARATUS

X-RAY TUBES



Nos. 87–40 to 87–50

The following four tubes are for use with small enclosed Static Machines and Spark Coils operated by battery current which give sparks of from four to six inches in length. We frequently have requests for X-Ray tubes to be used with small unenclosed Static Machines and small Ruhmkorff Coils, but none of these tubes will give satisfactory results and we have not included any in this series.

87–10 **AUTOMATICALLY ADJUSTED X-RAY TUBE,** 4 inches in diameter with heavy platinum target and with special attachment for maintaining automatically the proper degree of vacuum **$9.80**

87–15 **X-RAY TUBE,** 4 inches in diameter with heavy platinum anode the same as above, but without the automatic adjuster **7.50**

87–20 **AUTOMATICALLY ADJUSTED X-RAY TUBE,** 5¼ inches in diameter with heavy platinum anode and with automatic adjuster **12.25**

87–25 ——, 6 inches in diameter with heavy platinum anode and automatic adjuster **16.40**

The following three tubes are for use with large enclosed Static Machines and with large Induction Coils operated by power current with Electrolytic Interrupter.

87–40 **AUTOMATICALLY ADJUSTED X-RAY TUBE,** 6 inches in diameter with heavy platinum anode and automatic adjuster **$22.00**

87–45 ——, 7 inches in diameter with heavy platinum anode and automatic adjuster **27.75**

87–50 ——, 8 inches in diameter with heavy platinum anode and automatic adjuster **33.50**

The following two tubes are for use with Tesla and High Frequency Coils.

87–60 **AUTOMATICALLY ADJUSTED X-RAY TUBE,** 5¼ inches in diameter with especially constructed platinum anode and automatic adjuster **20.40**

87–65 ——, 6 inches in diameter with especially constructed platinum anode and automatic adjuster . . **22.60**

(We recommend the use of the above two tubes with our High Frequency Coils, Section **95**.)

The following three tubes are recommended for the very heaviest machines and the most exacting work that can be put upon the X-Ray tube. The anode is of heavy sheet Tungsten which will fuse only at a temperature of 3,000 Centigrade, and for X-Ray work is practically indestructible. These three tubes are the latest and best product in X-Ray tube construction.

87–70 **TUNGSTEN X-RAY TUBE,** latest construction, 6 inches in diameter **$38.00**

87–75 ——, same as above, 7 inches in diameter **44.50**

87–80 ——, 8 inches in diameter **49.25**

87–100 **SMALL X-RAY STAND,** universal adjustment **$2.50**

87–110 **LARGE X-RAY STAND,** with heavy iron base. This stand is four feet tall and is arranged for adjustment in all directions **11.00**

Nos. 87–125 to 87–145

87–125 **BARIUM PLATINO-CYANIDE FLUOROSCOPE AND SCREEN,** 3 × 4 inches **$8.25**

87–127 **BARIUM PLATINO-CYANIDE FLUOROSCOPE AND SCREEN,** 5 × 7 inches **16.80**

87–130 **BARIUM PLATINO-CYANIDE FLUOROSCOPE AND SCREEN,** 6 × 8 inches **19.25**

87–140 **CALCIUM TUNGSTATE FLUOROSCOPE AND SCREEN,** 5 × 7 inches **12.00**

87–145 **CALCIUM TUNGSTATE FLUOROSCOPE AND SCREEN,** 6 × 8 inches **13.50**

No. 87–175

87–175 **PROTECTOR** for X-Ray Tube. This Protector is of rubber and will fit over all sizes of tubes up to six inches in diameter **$8.75**

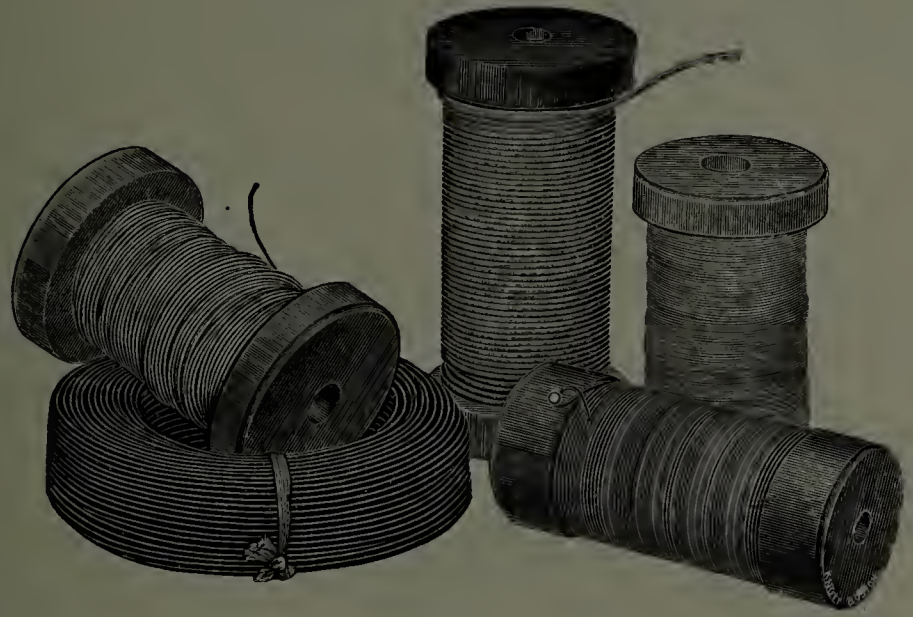
87–180 **PROTECTOR** for large X-Ray Tubes. This Protector is made of glass containing approximately 40 per cent. of lead, and should be used with tubes measuring 7 inches and 8 inches in diameter . **13.50**

No. 87–190

87–190 **EYE-GLASS PROTECTOR** to be worn by operator when doing X-Ray work **$3.00**

ELECTRICITY

ELECTRICAL SUPPLIES



90–10 COPPER WIRE, bare.

	a	b	c	d	e	f	g	h	i
B. & S. Gauge	16	18	20	22	24	26	27	28	30
Price per 1 oz. Spool									$0.20
Price per 4 oz. Spool			$0.25	.26	.30	.32	.35	.38	.35
Price per 1 lb. Spool	$0.75	.75	.80	.85	.90	.95	1.00	1.10	

90–15 COPPER ANNUNCIATOR WIRE, double cotton covered, paraffined. B. & S. Gauge No. 18. Per ½ Pound Coil **$0.40** Per Pound Coil **$0.75**

90–20 COPPER WIRE, double cotton covered.

	a	b	c	d	e	f	g	h	i	j
B. & S. Gauge	16	18	20	22	24	26	27	28	30	36
Price per 4 oz. Spool			$0.35	.40	.45	.50	.52	.55	.60	1.15
Price per 1 lb. Spool	$0.90	.95	1.00	1.05	1.10	1.35	1.40	1.60		

90–25 COPPER WIRE, enamel coated.

	a	b	c
B. & S. Gauge	28	30	36
Price per 4 oz. Spool	$0.85	1.35	1.95

90–30 FLEXIBLE WIRE, TINSEL WIRE, covered with green twisted braid . . . . . Per Yard **$0.20**

90–35 LAMP CORD, two conductors twisted, B. & S. Gauge No. 18, rubber and cotton insulation. Per Yard **.20**

90–40 THEATRE CABLE for 40 amperes current; advisable for use in lantern projection. This cable consists of two conductors, flexible, cotton wrapped, rubber covered, braided, twisted together with filler, and finished with two weather-proof braids . . . . . Per Yard **1.50**

90–45 SPRING BRASS WIRE.

	a	b	c	d	e
B. & S. Gauge	22	24	27	28	30
Price per 4 oz. Spool	$0.30	.32	.36	.40	.50

90–50 FUSE WIRE.

	a	b	c	d	e	f	g
Amperes	½	1	3	5	10	15	35
Price per yard	$0.07	.08	.10	.12	.18	.25	.40

90–55 GERMAN SILVER WIRE, 18 per cent. alloy, bare.

	a	b	c
B. & S. Gauge	26	28	30
Price per 4 oz. Spool	$0.48	.54	.60

90–60 GERMAN SILVER WIRE, 18 per cent. alloy, single cotton covered.

	a	b	bb	c	d	dd
B. & S. Gauge	18	20	24	28	30	36
Price per 4-oz. Spool	$0.75	1.00	1.10	1.20	2.00	
Price per 1 lb. Spool	$1.75					

90–70 IRON WIRE, soft drawn, bare.

	a	b	c	d
B. & S. Gauge	24	27	28	30
Price per 4 oz. Spool	$0.15	.18	.19	.20

90–75 IRON PICTURE WIRE, No. 1 . . . . . Per Package **$0.10**

90–80 LEAD WIRE, ⅛ inch diameter . . . . . Per Foot **.06**

90–95 SPECIAL HIGH RESISTANCE WIRE for use in resistance measurements, — especially valuable in determining the effect of temperature on resistance . . . . . Per 10 feet **.25**

57–10 PIANO WIRE, best quality imported, wound in coils, each weighing approximately ¼ pound.

	a	b	c	d
Diameter, inch	.028	.022	.0178	.014
Per Coil	$0.40	.45	.45	.55

90–100 PLATINUM WIRE.

	a	b	c	d	e	f
B. & S. Gauge	20	22	24	26	28	30

In view of the continual market fluctuations in the price of Platinum, we quote only on application.

90–105 ZINC WIRE, ⅛ inch diameter . . . . . Per Foot **$0.20**

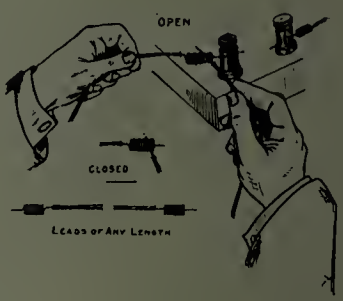
90–150 ARTIFICIAL LIGHT CIRCUIT for reproducing, within the laboratory, conditions similar to those of an actual incandescent lighting circuit as worked out in the Applied Electrical Laboratory of Pratt Institute.

A wire of known high resistance per mil-foot, resembling in appearance an ordinary incandescent lighting wire, but having an asbestos insulation to avoid danger of fire. In use this wire is strung along the side of a room or mounted on a movable frame using standard porcelain insulators and cleats, lamp sockets and switches.

Fifty-foot Artificial Lighting Circuit complete with special resistance wire, sufficient insulators, cleats, lamp sockets and switch, with full directions and diagrams for setting up **$8.75**

THE IMPROVED RAPID BATTERY CONNECTORS

Patent Pending



Nos. 90–175 to 90–180

As will be suggested from the cut, these battery connectors are made of a carefully proportioned spiral spring of phosphor-bronze wire, the proper size to give sufficient rigidity and at the same time to make them easy of connection.

The spirals being separated by a slight pull, the straight end of the next connector is readily slipped in place, making a secure electric contact which will not accidentally loosen in the course of the experiment.

These terminals are especially serviceable in laboratory work, since they have the important feature of being connected with equal facility to either an English or American form binding post. For parallel or multiple connection they are equally well suited. The use of this connector, therefore, does away with the multiplicity of connectors designed for meeting the conditions of various kinds of binding posts. It frequently happens that one type of instrument having an English post has to be connected with another having an American post. With the usual form of connectors this condition is very hard to meet. With the "Rapid" this difficulty is entirely overcome.

Please note the diagram for methods of connecting to English posts, to American posts, and for connecting in multiple and parallel circuits.

As will be noted from the listing below, these connectors are furnished in pairs or in quantity, without wire connections, also furnished with wire connections of varying length.

90–175 THE IMPROVED RAPID CONNECTING TIPS . . . . . Per Dozen **$0.25**
Per Hundred **2.00**

90–177 THE IMPROVED RAPID CONNECTORS, attached to connecting cord 6 inches long, especially designed for close connection, such as joining batteries in multiple and in series . . . Per Pair **.20**

90–179 THE IMPROVED RAPID CONNECTORS, attached to a connecting cord 2 feet long . . . . . Per Pair **$0.30**

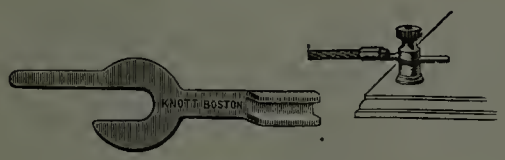
90–180 THE IMPROVED RAPID CONNECTORS, attached to a connecting cord 3 feet long . . . . . Per Pair **.40**

CONNECTORS

90–185 THE "PRIMO" POSITIVE CONTACT LECTURE TABLE CLASPS. These connectors are recommended for rapid connections in lecture table work. Connections to all styles of binding posts, both bare and insulated wire, can be made in an instant. The grip with teeth makes an excellent contact even through heavily insulated wires . . . . . Per Pair **.60**

90–187 THE "PRIMO" POSITIVE CONTACT LECTURE TABLE CONNECTOR. Consists of a pair of No. **90–185** Clasps with a 4-foot length of flexible, heavily insulated copper wire. Each **.80**

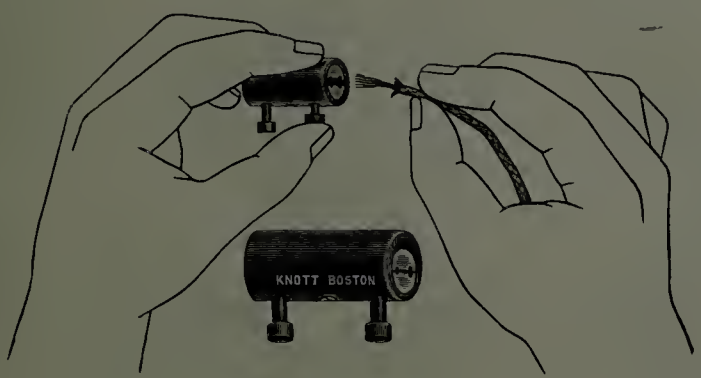
Nos. 90–185 to 90–187



No. 90–190

90–190 UNIVERSAL CONNECTOR TIP adapted to both English and American types of binding posts.

To make a convenient laboratory connector, cut a single connecting flexible cord to the desired length. Strip the insulation for one-half inch at each end, leaving the bare wires. Twist the bared wires between the fingers, place in the groove, and bend over with a vise or a pair of pliers until the wire is pinched firmly between the poles of the connector. Some prefer to touch the contact with a drop of solder before bending over . . . . . Each **$0.05**



No. 90–195

THE CADY HIGH POTENTIAL CONNECTOR

90–195 THE CADY INSULATED PINCH CONNECTOR, designed for high potential currents to insure safety to the worker and to guard against short circuit.

Every instructor and wireless worker has had his patience tried with the old-fashioned wire connectors. They waste time, they fail to grip the smaller sizes of wire and there is constant danger of short circuit and a ground through the operator.

The Cady Pinch Connector makes all these troubles vanish. There are no screws to turn, only a knob to press. By means of a strong spring inside the connector, a good contact is assured with any size of wire from 5/32-inch diameter to the thinnest wires and ribbons. The connector is completely insulated, being encased in hard rubber, insuring perfect insulation and safety in use.

These advantages make the Cady Pinch Connector invaluable for general experimental work and for lecture demonstration, especially when frequent changes in connections have to be made. For connecting the fine wires of vacuum tubes and in other high voltage experiments they will be found indispensable . . . . . Price Each **$0.95**

90–220 PORCELAIN INSULATING TUBE, after Fuller and Brownlee (Experiment 74) . . . . . **.12**

90–221 WOODEN CORES with ATTACHED BINDING POSTS for above . . . . . **.25**

BINDING POSTS, CONNECTORS, ETC.

All of our binding posts, connectors, etc., are manufactured in our own shop, accurately made from the best material, using special tools. By manufacturing in large quantities we are able to supply them at prices which will compare favorably with those commonly charged for similar articles of inferior material and workmanship. We desire to emphasize the fact that all binding posts leaving our factory are **finished** handsomely, polished and lacquered.

When ordering binding posts state whether screws and washers are desired or not. If screws are wanted state whether wood or machine, round or flat headed, and length.

At an additional expense of one cent each a screw of any kind or size, together with either one or two washers, will be supplied.

Each article herewith illustrated is represented full size.

No. 90–225
Each . **$0.90**

No. 90–235
Each . **$1.25**

No. 90–230
Each . **$0.90**

No. 90–240
Each . **$0.55**

No. 90–242
Each . **$0.45**

No. 90–245
Each . **$0.58**

No. 90–247
Each . **$0.26**

No. 90–250
Each . $0.14

No. 90–252
Each . $0.18

No. 90–254
Each . $0.55

No. 90–260
Each . $0.13

No. 90–262
Each . $0.12

No. 90–264
Each . $0.12

No. 90–265
Each . $0.12

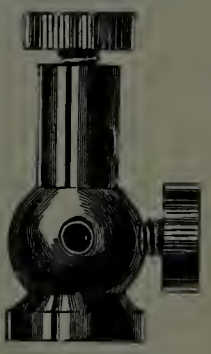
No. 90–270
Each . $0.45

No. 90–272
Each . $0.18

No. 90–274
Each . $0.15

No. 90–275
Each . $0.12

No. 90–280
Each . $0.20



No. 90–282
Each . $0.25

No. 90–284
Each . $0.16

No. 90–286
Each . $0.12

No. 90–288
Each . $0.12

No. 90–290
Each . $0.18

No. 90–295
Each . $0.16

No. 90–305
Platinum Tipped
Each . $0.75

No. 90–310
Each . $0.11

No. 90–312
Each . $0.10

No. 90–297
Each . $0.15

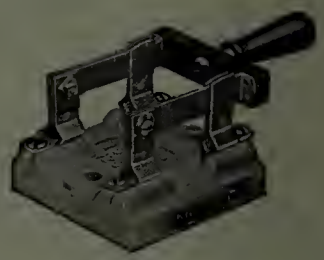
No. 90–299
Each . $0.15

No. 90–315 Triple Connectors . . . . . Each $0.18

BATTERY CARBON BINDING POSTS, see page 326.

SWITCHES

No. 90–325



No. 90–330

90–320 **CONNECTION BOARD,** after Fuller and Brownlee (Experiment **76**) **$3.00**

90–325 **SINGLE POLE, SINGLE THROW KNIFE SWITCH,** 15 amperes at 125 volts, mounted on porcelain base . . . . . **.55**

90–327 **SINGLE POLE, DOUBLE THROW KNIFE SWITCH,** 15 amperes at 125 volts, mounted on porcelain base . . . . . **.65**

90–330 **DOUBLE POLE, SINGLE THROW KNIFE SWITCH,** 15 amperes at 125 volts, mounted on porcelain base . . . . . **.65**

90–332 **DOUBLE POLE, DOUBLE THROW KNIFE SWITCH,** 15 amperes at 125 volts, mounted on porcelain base . . . . . **.90**

90–335 **DOUBLE POLE, DOUBLE THROW SWITCH,** capacity 50 amperes at 250 volts, heavy construction for lantern work **2.25**

No. 90–340

No. 90–352

No. 90–365

90–340 **POINT SWITCH,** wood base, brass terminals, one point **$0.18**

90–342 **POINT SWITCH,** wood base, brass terminals, two point . . . . . **.22**

90–350 **ONE-POINT RUBBER BASE SWITCH,** square base, with binding posts on front . . . . . **.80**

90–352 **TWO-POINT RUBBER BASE SWITCH,** square base, with binding posts on front . . . . . **.90**

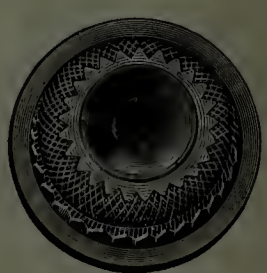
90–354 **THREE-POINT RUBBER BASE SWITCH,** square base, with binding posts on front **1.20**

90–356 **FOUR-POINT RUBBER BASE SWITCH,** square base, with binding posts on front **1.45**

90–365 **BATTERY RHEOSTAT AND SWITCH,** suitable for regulating miniature battery lamps, speed of small motors, etc.
This switch consists of six steps mounted on a polished wood base with hard rubber handle. Total resistance 5 ohms; trimmings nickel-plated **1.25**

No. 90–370

No. 90–375

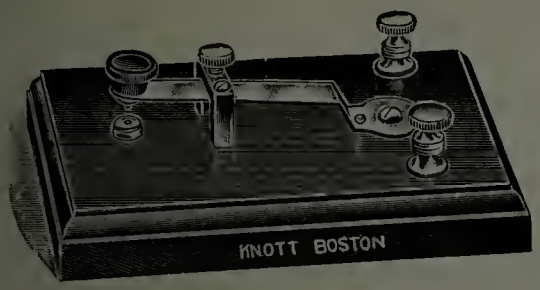


No. 90–380

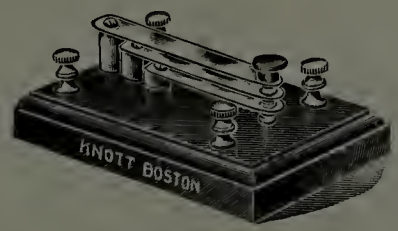
90–370 **WOOD PUSH BUTTON,** excellent quality, hard rubber button, hardwood antique oak finish . . **$0.10**

90–375 **DESK PUSH BUTTON,** for ⅝-inch hole, nickel-plated trim, light pearl button . . . . . **.28**

90–380 **METAL PUSH BUTTON,** hard rubber button, ornamented metal case, with screw holes. Diameter 2⅜ inches . . . . . **.45**



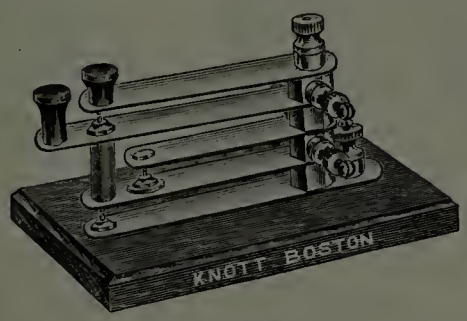
No. 90–390



No. 90–392

90–390 **SINGLE CONTACT KEY,** hardwood base, open circuit key with two binding posts **$0.78**

90–392 **DOUBLE CONTACT KEY,** hardwood base, open circuit with pair of binding posts for each circuit **2.60**



No. 90–395

90–395 **DOUGLASS UNIVERSAL DOUBLE CONTACT KEY.** With the possible exception of certain classes of condenser measurements, where the highest insulation is required, the Douglass Key will be found to be absolutely satisfactory.

The key is most universal in character as is shown by the following suggestions, which are a few of the uses to which it may be put.

The Douglass Key can be used,—

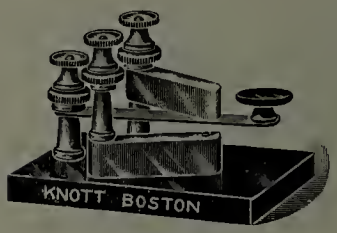
1. To close a single circuit.
2. To open a single circuit.
3. To close two separate circuits.
4. To close one circuit and open another simultaneously.
5. To open one circuit and close another.
6. To open connection with one circuit and close to a second.
7. To close one circuit, open the second and close the third in one movement.

It will thus be noted that the Douglass Key serves about every possible use in the laboratory with the exception of high capacity condenser work **$4.80**

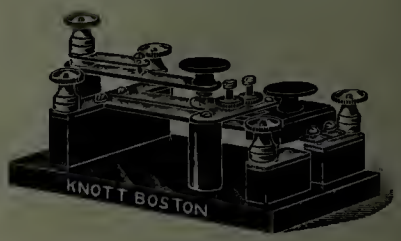
No. 90–410

90–410 **HIGH INSULATION DOUBLE CONTACT KEY.** This is a high-grade key, especially designed where extra high insulation is required. Heavy ebonite blocks and base, extra large binding posts and heavy platinum contact. All metal parts highly polished and lacquered. This is a handsome and serviceable key for general work **$12.00**

HIGH TENSION KEYS

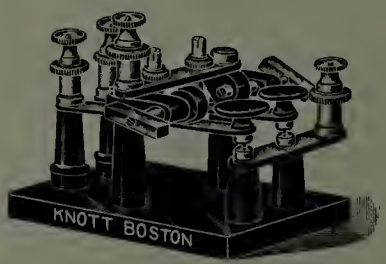


No. 90–415



No. 90–425

No. 90–420



No. 90–430

No. 90–435

The following keys and switches are recommended whenever one has occasion to use high voltages, to make high resistance measurements or accurate tests on condensers or other apparatus.

They are mounted on bases of pure ebonite, and where pillars are used the pillars also are of pure ebonite. Extreme care is used in construction, and our line will be found strictly high grade in every respect. The leakage factor is very low.

90–415 **SHORT CIRCUIT KEY** **$12.00**

90–420 **SINGLE PLUG SWITCH,** mounted on ebonite pillars, ebonite handle, spring capped plugs to prevent blocks being forced apart when plug is inserted **16.75**

90–425 **LAMBERT'S CAPACITY TEST KEY,** heavy ebonite blocks and pillars **22.50**

90–430 **RITCHIE REVERSING KEY** **24.50**

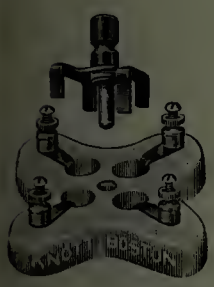
90–435 **KEMPE'S CHARGE AND DISCHARGE KEYS,** ebonite handles **20.00**

No. 90–460

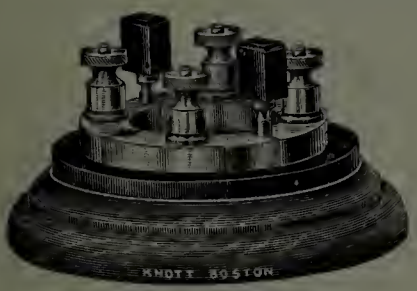
90–460 **INTERRUPTING WHEEL** for interrupting a current.

It is frequently desired in induction experiments to interrupt the current and also to vary the speed of the interruption. The design above illustrated consists of a toothed wheel mounted on an axle attached to the uprights on a neatly polished base. A spring contact arm rests against the toothed rim of the wheel. This spring contact arm is in electrical connection to one binding post and the pillar supporting the wheel to the other. If, therefore, connections are made to the binding posts the current will be interrupted by the teeth of the wheel as it is revolved by means of the crank. These interruptions are positive and the instrument is used to advantage connected in series with the primary of No. **95–40** Primary and Secondary Coil **$1.90**

COMMUTATORS



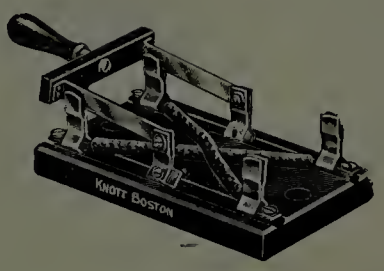
No. 90–470



No. 90–480

No. 90–475

No. 90–485



No. 90–490

90–470 **SIMPLE MERCURY CONTACT POLE CHANGER.** This is a simple standard form with improved mercury wells and contact. Handsomely finished base with four binding posts **$0.65**

90–475 **SPLIT RING POLE CHANGER,** consisting of a neatly polished wooden base on which are mounted four binding posts with connected contact arms which make contact with the top of the split ring reversing switch.

This switch is provided with a neat key-shaped hard rubber piece. All metal parts neatly polished and lacquered **1.75**

90–480 **PALMER'S PLUG FORM POLE CHANGER.** This form consists of a polished base on which are mounted four brass curved blocks, each block provided with a binding post. Current reversal secured by changing the position of the tapered plugs in the tapered holes. Brass parts neatly polished and finished **2.90**

90–485 **IMPROVED BLOCK HANDLE POHL'S COMMUTATOR.** The simple form above illustrated secures positive current reversals in a cleanly and efficient manner. The design, originated in our laboratories, consists of a polished wooden base with mercury wells, each well connected to a binding post with a non-detachable top. The pole changer is of the rocking type, securing instant current reversal by merely tipping from one pair of mercury wells to the other. All metal parts are handsomely polished and lacquered **1.90**

90–490 **KNIFE SWITCH POLE CHANGER,** mounted on slate base with visible connections. Will carry 15 amperes **1.55**

ELECTRIC BELLS

No. 90–525

90–525 **DISSECTIBLE IRON BOX BELL.** It will ring satisfactorily with one cell of battery and will not stick or buzz with six cells connected. The cover is of light pressed steel, neatly japanned. A slight pressure of the fingers on each side of the cover will disengage it from the clamps opening to view the entire mechanism. Gong 2½ inches in diameter **$0.45**

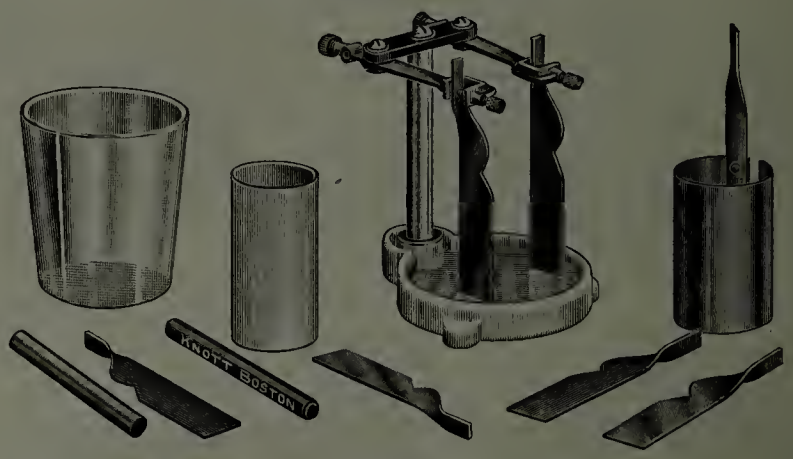
No. 90–555

90–545 **DISSECTIBLE IRON-CLAD BUZZER.** The buzzer listed under this number is in appearance the same as No. **90–525** Bell, without the gong, gong extension and striking rod **$0.55**

90–555 **SIX-INCH IRON-CLAD WATER-PROOF GONG.** This iron-clad bell is designed and constructed to protect the operating mechanism and magnets from dampness, dust, and other outside influences. The end of the striking rod is the only part of the working mechanism not contained inside the case and, as this is operated in a straight line, the opening in the case is very small and securely protected. The contact points are of hardened carbon, which permits of the use of a current ranging from 4 to 150 volts with magnets wound for proper resistance. The vibrations are strong, rapid, and regular.

Iron-Clad Water-proof Gong, resistance 5 ohms, gong 6 inches in diameter **6.25**

BATTERIES



No. 91–15

GILLEY-SKIDMORE BATTERY

91–10 PORCELAIN MOUNTED GILLEY-SKIDMORE BATTERY STAND for the study of the various phenomena of the voltaic cell. This stand has been used for a number of years and its extensive sale has been sufficient recommendation for it. It will be seen that the stand consists essentially of a recessed porcelain base with upright support. To the upright are fastened the two swiveled arms bearing the clamps. To these arms may be attached various accessories for the study of characteristics of different types of cells and also, in formulating the laws governing the action and efficiency of a simple single or two-fluid cell. This form of Students' Battery Outfit is recommended, since the wire leads are attached to the binding posts on the top of the stand, which has a broad base and hence avoids the tipping over of the battery which occurs in other types.

This cell is admirably adapted for its purpose and excels in simplicity of construction the much more expensive and bulky commercial cells. In the study of the leading types of batteries various accessories may be used to set up the complete cell. The cell is particularly adapted for the study of polarization, internal resistance, effects of different solutions, etc., and readily adapts itself to the construction of the Electro-motive Series. All parts are neatly finished and the battery presents a pleasing appearance in any laboratory.

Porcelain mounted Gilley-Skidmore Battery Stand only, without any accessory parts $1.20

91–12 PORCELAIN MOUNTED GILLEY SKIDMORE DEMONSTRATION CELL, complete with jar, copper, and zinc element for study of simple single fluid cell 1.40

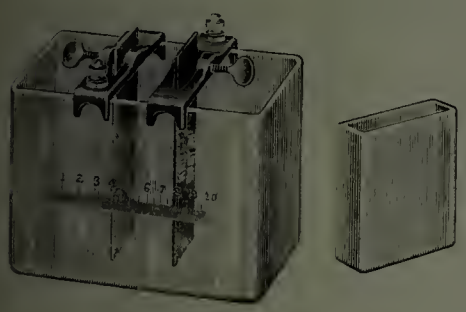
91–15 PORCELAIN MOUNTED GILLEY SKIDMORE BATTERY STUDY OUTFIT. Consists of stand complete with all the accessories listed below 2.40

SEPARATE PARTS

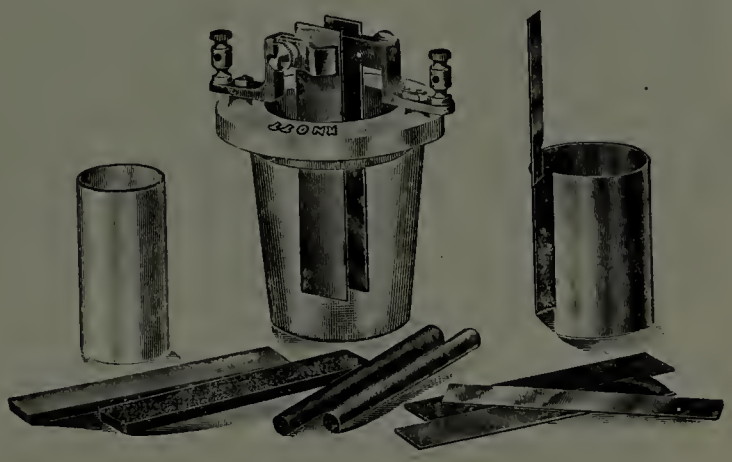
91–15a	**JAR**	$0.06
91–15b	**POROUS CUP,** 3 × 7.5 centimeters inside diameter	.15
91–15c	**ZINC PENCIL,** ⅜ inch diameter	.11
91–15d	**CARBON PENCIL,** ⅜ inch diameter	.11
91–15e	**ZINC ELEMENT,** right angle stem	.08
91–15f	**COPPER ELEMENT,** right angle stem	.08
91–15g	**IRON ELEMENT,** right angle stem	.07
91–15h	**ALUMINUM ELEMENT,** right angle stem	.10
91–15i	**LEAD ELEMENT,** right angle stem	.07
91–15j	**PURE BLOCK TIN ELEMENT,** right angle stem	.20
91–15k	**COPPER CYLINDRICAL ELEMENT**	.25

91–25 TURNER AND HERSEY TAPERING ZINC ELEMENT for use with above outfit in the study of polarization 08

The **GILLEY SKIDMORE BATTERY STAND,** with its porcelain base and swiveled arms, overcomes the many inconveniences encountered in the following designs which we offer to meet the demands of individual teachers. If the following designs are best adapted to individual needs, we wish to assure customers that the quality of material and workmanship is above question. We unhesitatingly recommend, however, our **PORCELAIN MOUNTED SKIDMORE OUTFITS.**



No. 91–30 Porous Cup of No. 91–35



No. 91–42

91–30 GOTHAM DEMONSTRATION CELL. Consists of a Rectangular Glass Jar with a millimeter scale etched on the front for convenience in measuring the separation of the elements. The element holders are of non-corrosive metal and are cast in a most convenient shape for resting on the jar and for clamping and adjusting the elements.

Complete with a Copper and Zinc Element for study of a simple single fluid cell $1.40

91–35 GOTHAM DEMONSTRATION BATTERY STUDY OUTFIT. Consists of the Rectangular Jar with ruled front, a pair of non-corrosive metal Element Holders and the Zinc and Copper Elements of above cell, with the addition of a special Rectangular Porous Cup, round Carbon and Zinc Elements and flat Elements of Aluminum, Carbon, Copper, Iron, Lead, Nickel and Tin.

Complete 2.10

91–40 HALL'S IMPROVED DEMONSTRATION CELL. In this design, we have discarded the construction using a metal cap for the jar, now using a neat porcelain cap moulded to fit the rim of the jar. To this porcelain cap are attached the special arms which bear the clamps. These clamps will hold either the round or flat elements. The method of mounting to the porcelain cap permits of adjusting the distance of the two elements at will.

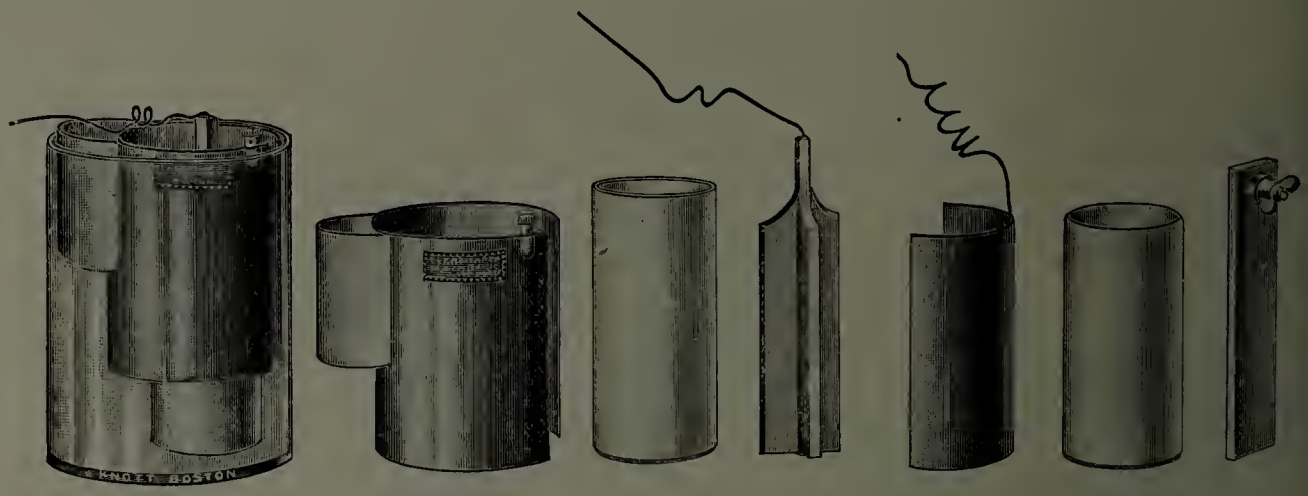
Jar, Porcelain Cap with attached Bracket and Clamps and Zinc and Copper Elements for study of a simple single fluid cell 66

91–42 HALL'S IMPROVED DEMONSTRATION BATTERY STUDY OUTFIT. Complete with all accessories listed below, including the special copper cylindrical element.

Complete 1.55

ACCESSORIES

91–43	JAR	$0.06
91–44	POROUS CUP, inside measurements 3 × 7.5 centimeters	.15
91–45	ZINC PENCIL	.11
91–46	CARBON PENCIL	.11
91–47	ZINC ELEMENT, flat	.05
91–48	COPPER ELEMENT, flat	.05
91–49	LEAD ELEMENT, flat	.05
91–50	IRON ELEMENT, flat	.05
91–51	ALUMINUM ELEMENT, flat	.05
91–52	TIN ELEMENT, flat	.11
91–53	COPPER CYLINDRICAL ELEMENT	.25
91–54	CARBON ELEMENT, flat	.11



No. 91-75 No. 91-90

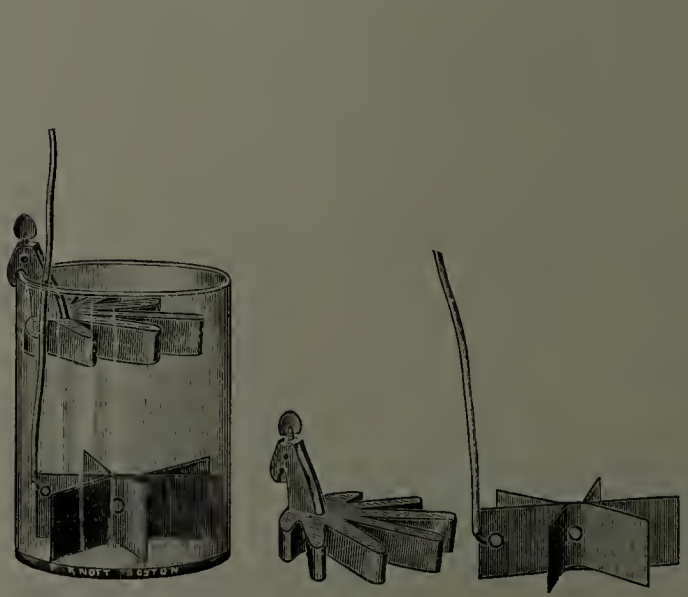
91-65 LECLANCHE BATTERY, especially adapted for "open circuit" work, most frequently used in bell service. E. M. F. about 1.4 volts.

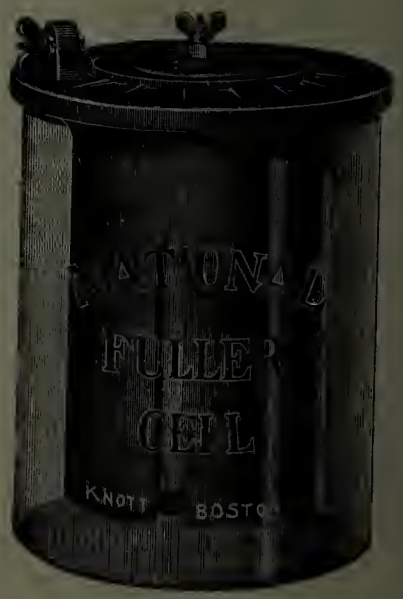
Cell complete $0.75
- **91-67 POROUS CUP,** sealed 40
- **91-68 ZINC PENCIL,** with binding screw 10
- **91-69 JAR** 25

91-75 GALLON STANDARD DANIELL CELL. This cell has attained the position of a standard laboratory cell, being readily adapted to all kinds of circuit work. Its E. M. F. is about 1.08 volts, this voltage remaining constant throughout the life of the cell. For this reason it may be seen that it is of great value for work in electrical experiments.

Cell complete, one gallon size, including Jar and Porous Cup, special Copper Cylinder with holder, and Zinc Element 2.60
- **31-265c JAR** 40
- **91-77 POROUS CUP** 25
- **91-79 ZINC ELEMENT** 1.10
- **91-80 COPPER CYLINDER** 95

91-90 QUART STUDENTS' DANIELL CELL, complete, including jar not illustrated 95
- **91-92 POROUS CUP,** 2 × 4 inches 20
- **91-94 ZINC ELEMENT WITH BINDING POST** 35
- **91-96 COPPER ELEMENT** 15
- **31-265b JAR** 25





No. 91-105 No. 91-120

91-105 CROW FOOT GRAVITY CELL, one of the most popular closed circuit cells, very largely used by telegraph and telephone companies, gallon size, complete $2.10
- **91-107 ZINC ELEMENT,** crow foot type 1.40
- **91-110 COPPER ELEMENT** 30
- **31-265c JAR** 40

91-120 IMPROVED FULLER CELL, for general laboratory service, open or closed circuits. This cell has unusually high E. M. F., about 2.4 volts, with internal resistance of .4 ohm, gallon size complete. 2.65
- **91-122 POROUS CUP,** 3 × 7 inches 25
- **91-124 ZINC ELEMENT** 1.20
- **91-135 CARBON CYLINDER** 80
- **31-265c JAR,** 6 × 8 inches 40

No. 91–165

No. 91–190

91–165 BUNSEN CELL, a two-fluid cell for "open circuit" work. E. M. F. approximately 1.9 volts, internal resistance about 1.8 ohms.

Bunsen Cell complete, one quart size $2.20

91–166 JAR, 4½ × 4½ inches 50

91–167 POROUS CUP, 2½ × 5 inches 25

91–169 ZINC ELEMENT, special shape with binding post 1.25

91–170 FLUTED CARBON ELEMENT, with connector and binding post 20

91–180 GRENET BATTERY, especially adapted for experimental and demonstrative work. This battery occupies little space and furnishes a powerful current for a short time. E. M. F. is approximately 2 volts at the start with very small internal resistance.

A further advantage of this type of cell is that the zinc element may be raised from the fluid, thus stopping action of the cell, and preserving the strength of the solution.

One-pint size complete 2.10

91–182 ZINC ELEMENT 25

91–184 CARBON ELEMENT 25

91–186 JAR 95

91–190 GRENET BATTERY, similar to above, but one-quart size, complete 2.75

91–192 ZINC ELEMENT 28

91–194 CARBON ELEMENT 35

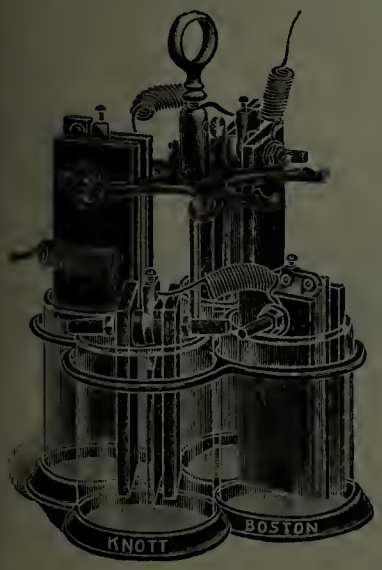
91–196 JAR 1.15

91–205 GRENET BATTERY, similar to above, but two-quart size, complete 4.20

91–207 ZINC ELEMENT 35

91–209 CARBON ELEMENT 50

91–210 JAR 1.75



No. 91–245

91–245 FOUR-CELL STUDENTS' PLUNGE BATTERY. This is a simple combination of Chromic Acid Cells provided with adjusting features which permit of lifting one or more cells from the solutions. It may be used to advantage on the demonstration table, but has been designed particularly for students' experiments.

Complete as illustrated, four-cell type 6.50

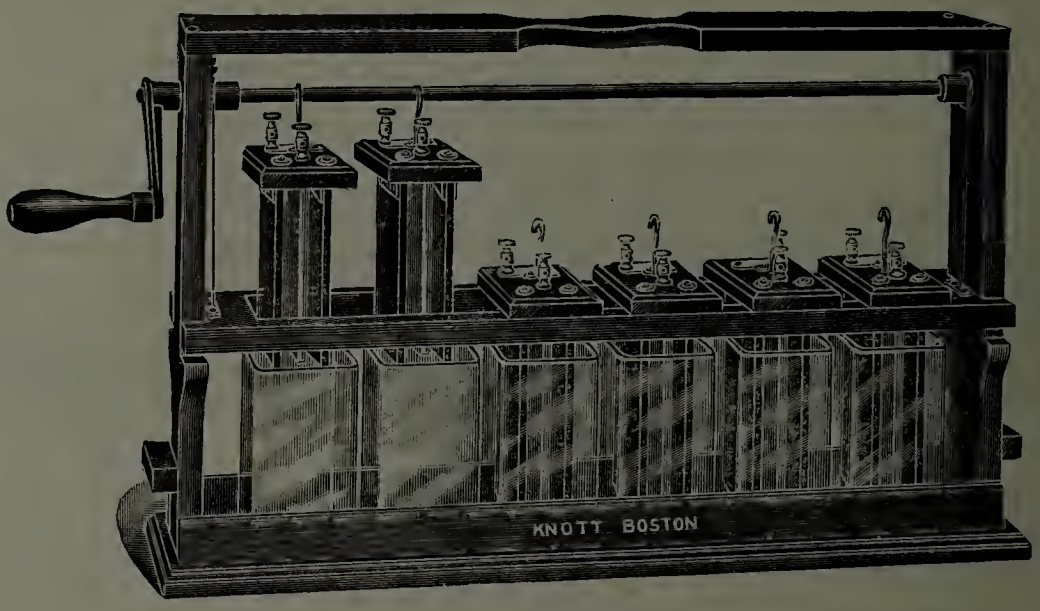
91–247 TWO-CELL STUDENTS' PLUNGE BATTERY, similar to above, but arranged for two cells only 4.15

91–250 COMPLETE ELEMENT, including two carbons and one zinc element with all connections 1.45

91–252 CARBON ELEMENT 25

91–254 ZINC ELEMENT 40

31–265a SPECIAL BATTERY JAR 12



No. 91–225

91–225 **SIX–CELL HIGH SCHOOL PLUNGE BATTERY.** Perhaps no source of current for lecture table or general laboratory work has become so desirable as that furnished by the Chromic Acid Cell. In the design illustrated above may be noted a form of portable cell which has found great favor throughout the country. Each cell is a unit in itself delivering about 2 volts and very powerful current for a short time. One or more may be combined in series or parallel to give a large E. M. F. or amperage.

The type is arranged so that from one to six cells may be used as desired. All six may be placed at one time in the solution. If it is desired that only four be used, as above, two may be suspended to the cross rod.

This battery is substantially made, provided with every convenience for safe use, and will be found indispensable when once used.

Complete as illustrated, arranged for six cells **$27.40**

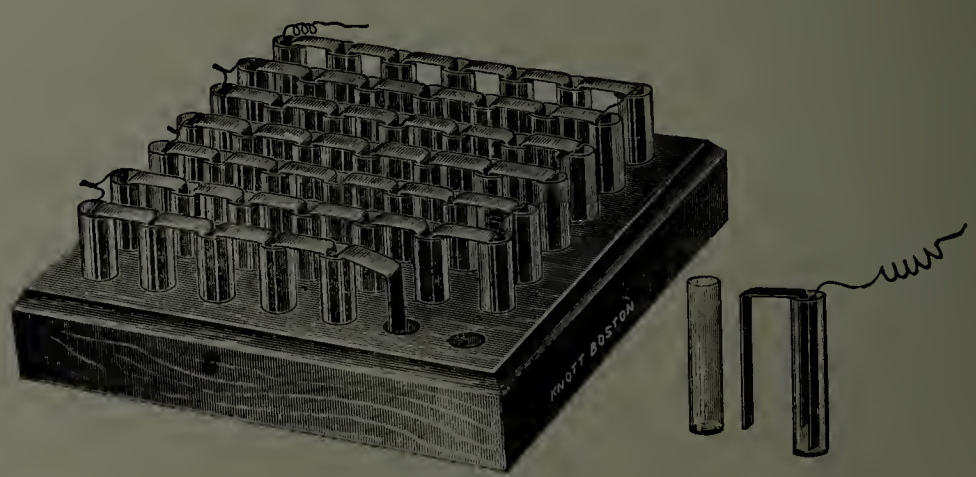
91–227 **FOUR–CELL SCHOOL PLUNGE BATTERY,** same as above, but arranged for four cells . . . **19.75**

91–229 **COMPLETE ELEMENT,** including top, two carbon, and zinc elements **3.00**

91–231 **CARBON ELEMENT** . . . . . **.30**

91–233 **ZINC ELEMENT** **1.30**

91–235 **SQUARE BATTERY JAR** . . . . . **.45**

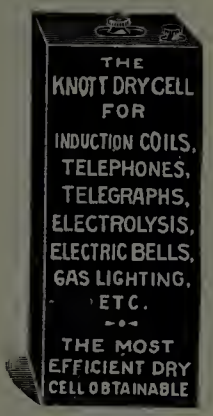


No. 83–250

83–250 **WATER BATTERY,** 50 cells, mounted on substantial neatly finished wooden base.
This battery is particularly adapted to advanced work when high voltage and low amperage are desired. It will be found a most serviceable battery for all electrostatic and electrometer work . **$6.25**

83–252 **——,** same as above, but comprising 100 cells. This battery is a combination of two of the above . **12.75**

No. 91–280



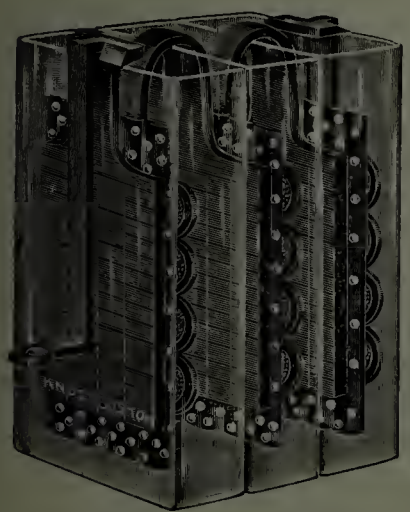
No. 91–300

91–280 **MOUNTED H-FORM STANDARD CELL.** This cell is furnished appropriately mounted on base provided with binding posts. It is designed that students may assemble their own cells. Complete as illustrated **$2.30**

91–282 **H-FORM STANDARD CELL,** same as above but unmounted, glass part only with sealed-in platinum electrodes **1.75**

91–300 **DRY CELL.** In our seventeen years' experience we have experimented with a great number of dry cells. For length of life, high electro-motive force, and low internal resistance we believe that the cell illustrated above is unexcelled. It polarizes slowly and recovers rapidly. We have no hesitancy in recommending its use for general laboratory work . . . . . **.40**

STORAGE BATTERIES



Nos. 91–325 to 91–330

Nos. 91–335 to 91–350

91–315 **MOUNTED LEAD PLATES** after Millikan and Gale. Fig. 277 . . . . . .Pair **$1.50**

91–325 **STORAGE BATTERY, LEAD-LEAD TYPE.** The plates measure 3¼ inches square, and the glass jar is 6½ inches high. The cell has a capacity of six ampere hours at an E. M. F. of two volts . **2.15**

91–330 ——, same as above, but a much larger cell, and is recommended for such work as operating Ruhmkorff coils, performing electrolysis experiments, and other laboratory work where a heavy current is necessary. The lead plates measure 7¾ inches square and are contained in a glass jar 11¾ inches high × 9 inches wide × 3½ inches deep. The capacity of each cell is 36 ampere hours at an E. M. F. of two volts **6.75**
We recommend either three or four cells as the proper laboratory outfit.

91–335 **PORTABLE STORAGE BATTERY,** enclosed in wooden case as shown in the illustration. Capacity 60 ampere hours at an E. M. F. of six volts **21.00**

91–340 ——, same as above, capacity 80 ampere hours at an E. M. F. of six volts **27.25**

91–345 ——, same as above, capacity 100 ampere hours at an E. M. F. of six volts **32.50**

91–350 ——, same as above, capacity 80 ampere hours at an E. M. F. of eight volts **36.00**

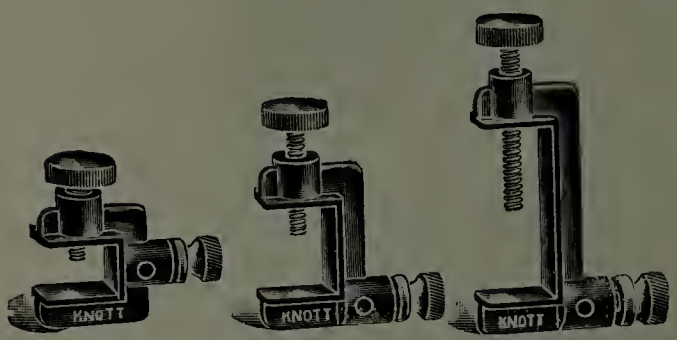
BATTERY SUPPLIES

31–265 BATTERY JARS, of excellent quality.

	a	b	c	d
Size, inches	2¼ × 3¼	4 × 5	6 × 8	8 × 12
Each	$0.12	.25	.40	1.50

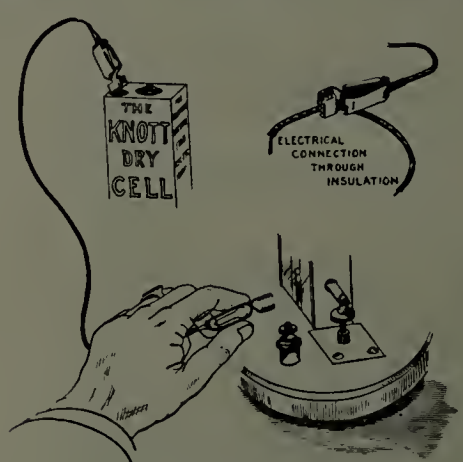
91–380 RECTANGULAR BATTERY JARS, of excellent quality.

	a	b
Size, inches	2½ × 4¼ × 7	4 × 4 × 8
Each	$0.35	.45



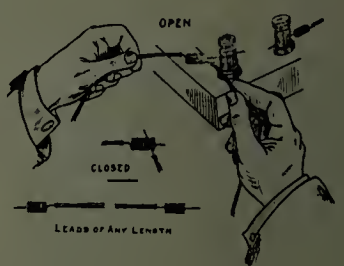
No. 91–410a No. 91–410b No. 91–410c

Nos. 90–175 to 90–180



Nos. 90–185 to 90–187

No. 90–195



No. 90–185

91–410 CARBON AND ZINC BATTERY CONNECTORS.

	a	b	c
For plates	¼ to ⅜	⅜ to ¾	¾ to 1¼ inches
Each	$0.20	.35	.42

THE IMPROVED RAPID BATTERY CONNECTORS

(For description see page 312)

90–175 THE IMPROVED RAPID CONNECTING TIPS . . . . . Per dozen $0.25
Per hundred 2.00

90–177 THE IMPROVED RAPID CONNECTORS, a six-inch flexible cord with a Connecting Tip No. **90–175** at each end . . . . . Each .20

90–179 ——, a two-foot flexible cord with a Connecting Tip No. **90–175** at each end . . . . . Each .30

90–180 ——, a three-foot flexible cord with a Connecting Tip No. **90–175** at each end . . . . . Each .40

90–185 THE "PRIMO" POSITIVE CONTACT LECTURE TABLE CLASPS. (For description see page 312.) . . . . . Per Pair .60

90–187 THE "PRIMO" POSITIVE CONTACT LECTURE TABLE CONNECTOR, a four-foot flexible cord with a Clasp No. **90–185** at each end . . . . . Each .80

90–190 UNIVERSAL CONNECTOR TIP for either the English or American Binding Post. (See page 313.) Each .05

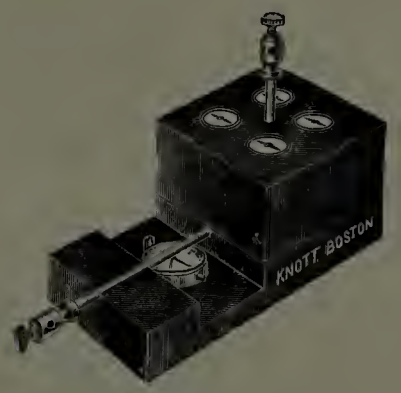
90–195 CADY INSULATED CONNECTOR (See page 313) . . . . . Each .95

ELECTRO-MAGNETISM

No. 92–15

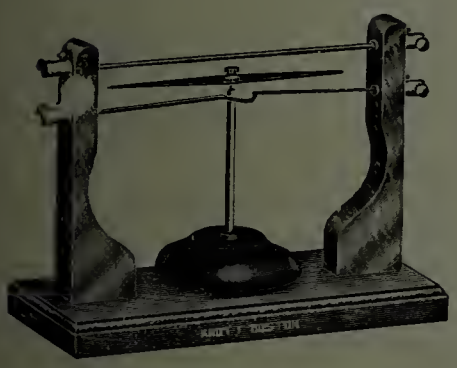
92–15 AMPERE'S LAW STAND, a convenient stand with clamp for holding a No. 10 copper conducting rod; with shelf for arranging small compasses about the conductor and binding posts for connecting the lead wires.

Full directions for the experiment will be found in the National Physics Direction Sheets, Experiment E041, a copy of which will be furnished with each instrument . . . **$1.45**

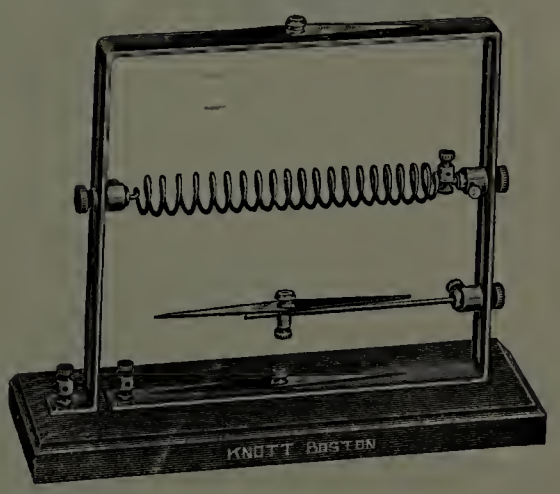


No. 92–17

92–17 AMPERE'S LAW APPARATUS (Fuller & Brownlee, Exp. 81). Complete as illustrated with four sealed-in exploring compasses, but without the larger movable magnetic compass **$2.65**



No. 92–20



No. 92–30

92–20 OERSTED'S LAW APPARATUS, for study of magnetic action of currents and formulating Ampere's rule.

This apparatus consists of a base to which are mounted two pillars, each provided with two binding posts, one each for the terminals of the parallel conducting wires. A sensitive magnetic needle separately mounted on a base of its own is readily adjusted so that its point of support comes midway between the parallel wires. This mounted magnetic needle is our No. **81–12** and will not be required if already a part of the equipment. **$2.85**

92–22 OERSTED'S LAW APPARATUS FRAME, only without mounted magnetic needle **2.25**

81–12 MOUNTED MAGNETIC NEEDLE, as used in No. **92–20** . . . . . **.60**

92–30 HELIX OERSTED'S LAW APPARATUS, for a study of the directive action which a fixed current exerts at a distance on a magnetic needle, and for formulating Ampere's Rule. This, our **adjustable needle** and **adjustable helix design,** consists of a rectangular metal frame mounted as illustrated on a polished wooden base. The upright parallel sides of this frame are slotted to carry the holders for the movable needle and for the helix. That a study of the effect of a current through a helix on a magnetic needle may be noted, the holders of the helix are provided with a pair of binding posts, one on each end. A pair of binding posts is also furnished for connecting a current to the rectangular frame. Two fixed needles, one over the upper part of the frame and one within the frame over the under side, and a movable needle which may be fixed in any position within the frame indicate the directive action of a current on a magnetic needle.

All metal parts of this apparatus are finely polished and lacquered and the needles are delicately balanced on steel pivot points.

Complete as illustrated, with three needles and helix attachment **5.50**

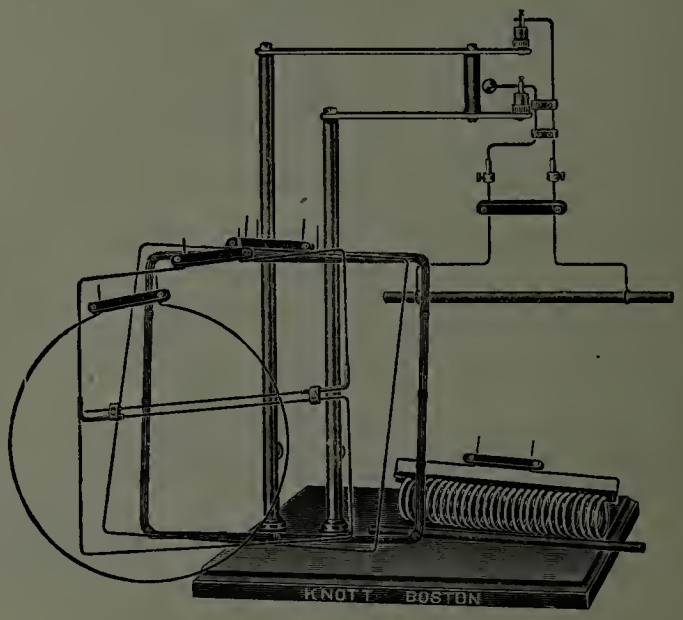
92–35 SIMPLE ADJUSTABLE NEEDLE OERSTED'S LAW APPARATUS. This design is essentially the same as illustrated and described above. It is, however, furnished without the helix attachment and without the two fixed needles. As may be readily noted, by means of this movable needle, the holder movable in height and the needle movable along the holder, practically any position within and, if desired, outside the frame may be secured **3.75**

92–37 HELIX ATTACHMENT, for attachment to above frame in study of the directive action of a current through a helix upon a magnetic needle.

This attachment is provided with clamps for instant clamping to the slotted upright parallel sides of the frame . . . . . **.85**

92–40 BAR OF IRON and BAR OF WOOD, for placing within helix attachment above for a study of the magnetic effects produced . . . . . Per Pair **.15**

AMPERE'S LAW



No. 92–50

92–50 **AMPERE'S FRAME,** illustrating various phenomena due to the magnetic effects of an electric current.

The design, improved in many ways incapable of illustration, consists essentially of a base to which are mounted two metal uprights. At the tops of these uprights are attached arms carrying at their extremities two steel cups for mercury in which are placed the pivoting points of an improved suspension device carefully balanced by means of a metal ball and provided with sockets and binding screws for attaching the different contact frames.

These frames are designed to illustrate in a satisfactory manner several interesting and instructive phenomena, each frame interchangeable in the suspension device. Five frames are furnished, — a loop, a rectangle, an astatic rectangle, a rectangular coil, and a solenoid. In addition there is furnished a suspension frame for a bar magnet and a soft iron rod.

Perhaps no single piece of apparatus designed for the study of magnetism has such wide application as does this time-honored Ampere's frame. Results are strikingly illustrated with the minimum of annoyance. In our design we have endeavored to obviate the previous sources of difficulty in the old forms and are enabled by our many improvements to guarantee satisfactory results.

The design is capable of demonstrating in a positive manner:

1. Mutual Action of Magnets and Solenoids.
2. Action of Currents on Solenoids.
3. Directive Action of the Earth on Solenoids.
4. Directive Action of Magnets on Currents.
5. "Sucking Effects" of Solenoids.
6. Action of a Current on a Pivoted Magnet.

Apparatus complete, as illustrated, including all accessories described above **$11.00**

No. 92–60

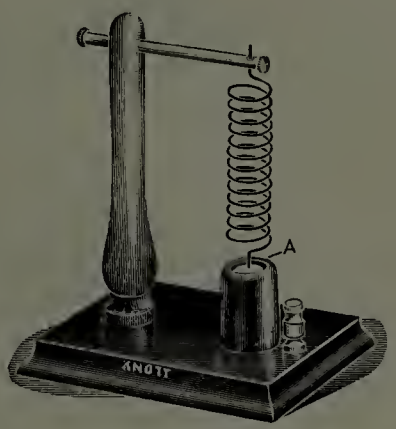
92–60 **FLOATING HELIX AND CELL,** for demonstrating the magnetic polarity of an electro magnetic solenoid.

This apparatus consists of a small cell, the leads of which are formed into a horizontal solenoid. In use the elements are placed into the small jar held in a disc of cork, and the whole placed in a jar of water where the combination will float upright. The solenoid will soon take a position so that the axes will point true North and South. From further tests with a bar magnet it will be noted that the solenoid will act the same as a magnetic needle, one end developing South and the other North polarity.

Cell complete as illustrated **1.60**

PARALLEL CURRENT APPARATUS

No. 80–305



No. 80–310

80–305 **PARALLEL CURRENT APPARATUS,** for illustrating mutual actions of parallel currents. The design consists of an insulated stand to the head of which are attached binding posts in electrical connections with two bent copper wires. To these bent wires are suspended two small straight copper rods cut to the proper length, which will allow their free ends to extend within the mercury well set in the base.

In use it is always best to amalgamate the ends of these copper rods. Success of the experiment depends also upon allowing the rods to just make contact with the surface of the mercury. Parallel currents flowing in the same direction may be secured by connecting both binding posts with one pole of the battery; the other pole should be connected to a binding post (not shown in illustration) fastened to the base and in electrical connection with the mercury well.

Parallel currents running in opposite directions may be obtained by simply connecting the battery terminals and the binding posts, at the top.

In the first case, repulsion of the wires will be noted; in the second, attraction **$1.85**

80–310 **CONTRACTING HELIX,** illustrating the mutual action of currents.

This apparatus consists of a spiral of copper wire, one end of which is suspended from a rigid arm, the other end free to dip into a well of mercury located in the base. If current is allowed to flow through the spiral, attraction between the convolutions causes the coil to contract, and the end to be lifted out of the cup of mercury, thus breaking the circuit when current and attraction cease, and the wire dips again into the mercury. A rapid and vibratory motion, therefore, is produced **1.35**

No. 92–75

92–75 **PARALLEL CURRENT REPULSION COILS** with **BIFILAR SUSPENSION,** designed to teach the mutual influence of parallel currents and self-induction. One of the coils when used separately is well adapted for experiments on the Earth's Magnetic Field.

The apparatus consists of two carefully constructed form-wound coils of 1000 turns double cotton covered copper wire. Each coil is taped, shellaced and baked. Provided with binding posts for bifilar suspension.

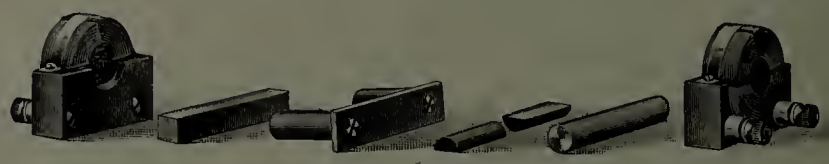
As the illustration indicates, the coils are suspended by an adjustable clamp fitting a vertical rod of from 13 to 19 millimeters in diameter, the clamp being so designed that the distance between the coils may be varied at will. Connections to the coils from the clamp are such that they are readily joined either in multiple or in series according to the current available. The coils are wound for resistance to take 110 volt direct current when running in series.

Price complete without stand **7.75**

NOTE. When one of these coils is used for experiments in Earth Induction, we recommend the use of our Lecture Table Galvanometer No. 93–130.

92–77 **COIL FOR MAGNETIC INDUCTION.** A form wound coil with connectors and flexible leads. When the single coil is connected in series with any sensitive galvanometer, interesting experiments showing the earth's magnetic field and other induction phenomena may be performed. The purchase of complete apparatus as described above (No. **92–75**) for demonstrating also mutual and self induction is recommended **$2.70**

ELECTRO-MAGNETS



Figs. 1 2 3 4 5 6

Figs. 7 8 9

Nos. 92–110 to 92–130

92–100 **STUDENTS' ELECTRO-MAGNET,** simple electro-magnet capable of complete demonstration of magnetic induction **$0.65**

92–110 **GILLEY INDUCTION COILS,** mounted with binding posts.

These coils are designed for students' use in the study of Induction and Electro-magnetism. Carefully prepared students' directions for their use will be found in the Turner and Hersey series of experiments, E042, E150 and E153. Copies of these experiment sheets are furnished with each pair of coils.

As the illustration indicates, the coils are form-wound, shellaced and baked so as to make a rigid unit and mounted on a conveniently designed wood base with binding posts, the form of the base being such as to permit the greatest freedom of use in the experiments for which they are intended. The hole in the center is of the correct size to take the soft iron armature in the study of electro-magnets. Sold by the pair only . . . . . Per Pair **1.40**

ACCESSORY APPARATUS FOR THE STUDY OF INDUCTION AND ELECTRO-MAGNETS USING THE GILLEY COILS

Each of the items listed and illustrated in Figures **2, 3, 4, 5** and **7,** are designed for use with the Gilley Coils in performing experiments outlined in the National Loose-Leaf Sheets above referred to.

92–115 **SOFT IRON U-SHAPED CORE,** Fig. **3,** for study of bipolar electro-magnets . . . . . Each **$0.20**

92–117 **SOFT IRON ARMATURE,** Fig. **2,** for use with the above core in the study of electro-magnets, Each **.10**

92–120 **SOFT IRON CORE,** Fig. **5,** single, for the study of electro-magnets . . . . . Each **.10**

92–122 **PAIR OF HALF-ROUND CORE PIECES,** Fig. **4,** for mapping the lines of force in an electro-magnet. Per Pair **.15**

92–125 **PAIR OF SLOTTED CARDBOARDS,** Fig. **7,** for mapping lines of force. . . . . Per Pair **.08**

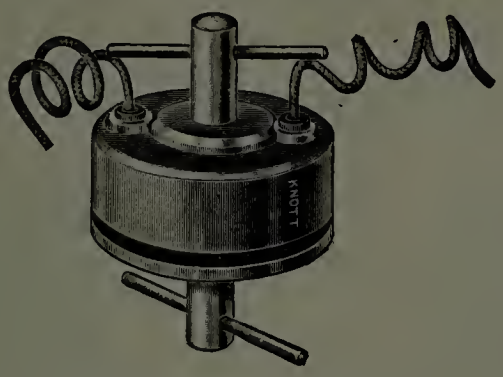
Figures **8** and **9** in the illustration show how the above apparatus is used in the study of the Simple Transformer, Induced Currents and Electro-Magnet.

92–130 **COMPLETE GILLEY INDUCTION OUTFIT,** supplied in box, with direction sheets **$2.00**

No. 92–135

92–135 **ELECTROMAGNETIC COILS,**—a set of three coils varying in number of turns and character of core, as called for in Brownlee & Fuller's "Laboratory Exercises," Exp. 82 . . **1.50**

92–136 ——, a set of two coils after Millikan, Gale and Bishop, Exp. 30 Per Set **1.10**



Nos. 92–150 to 92–152

92–150 **INSTITUTE IRON CLAD MAGNET,** Commercial Form, 300 lbs. capacity.
In the design of this magnet careful study has been made of commercial types in use. The defects of previously designed laboratory instruments have been corrected, with the idea of giving the maximum efficiency per pound of weight. We believe this to be the only laboratory lifting magnet on the market in which the cross section area of the shell is equal to that of the core which, of course, is necessary in order to secure the highest efficiency per pound. The success which we have attained may be roughly indicated from the fact that on one cell of dry battery, this magnet will lift approximately thirty times its own weight.
In actual use, we recommend a voltage of from 4 to 6 volts, the latter emf., of course, giving the best results.
Size, 4 × 1½ inches, weight with armature, 5 pounds, resistance, 1/3 ohm. $4.50

92–152 **INSTITUTE IRON CLAD MAGNET,** same as above, but smaller in size 2.25

No. 92–160

No. 92–175

No. 92–185

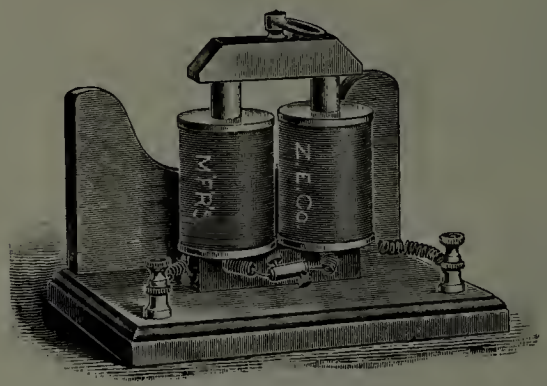
92–160 **SIX-INCH DEMONSTRATION ELECTRO-MAGNET.** This instrument is intended for use on a battery circuit and illustrates in a most striking manner the great magnetic pull obtained from a U-shaped core.
The two windings of this magnet can be connected either in multiple or in series. Requires five or ten volts, depending upon method of connecting coils.
Core (6 × ¾ inches) is of special grade of soft iron. 2.35

92–165 **FOUR AND ONE-HALF INCH HELIX ELECTRO-MAGNET.** New York State form 1.35

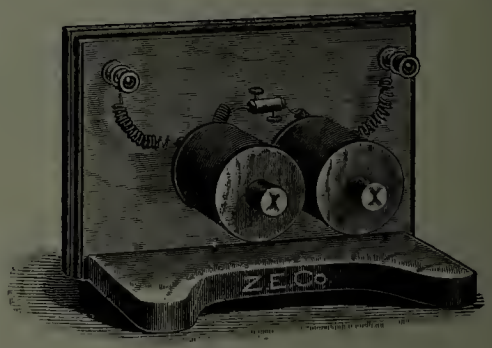
92–175 **HELIX AND SEPARABLE MAGNETIC CIRCUIT (HELIX AND RING),** for demonstrating magnetization by current.
This apparatus consists of two symmetrical U-shaped soft iron rods each with a handle. A detachable form-wound helix is fastened to one branch of one of these U-shaped pieces so that when the ends of the U's are placed together to form a closed magnetic circuit half of the helix will cover one of the branches of one of the U's and half of the corresponding branch of the other U.
Before battery is connected no magnetism is noticeable, but as soon as current is allowed to pass through the helix considerable force is needed to separate the U's.
Complete as illustrated 2.90

92–185 **SOLENOID MAGNET,** for illustrating the principle of a solenoid magnet.
This apparatus consists of a glass tube closed at one end and on which is fastened a helix of wire. If now a bar of soft iron is placed so that it rests on the closed end and the helix is connected to source of current supply, the "sucking" effect of the magnetic force is immediately demonstrated.
Complete as illustrated with soft iron rod 1.70

92–187 **HELIX** or **SOLENOID** with **MOVABLE COIL.** Helix 4½ inches long with connectors 90



Upright Position



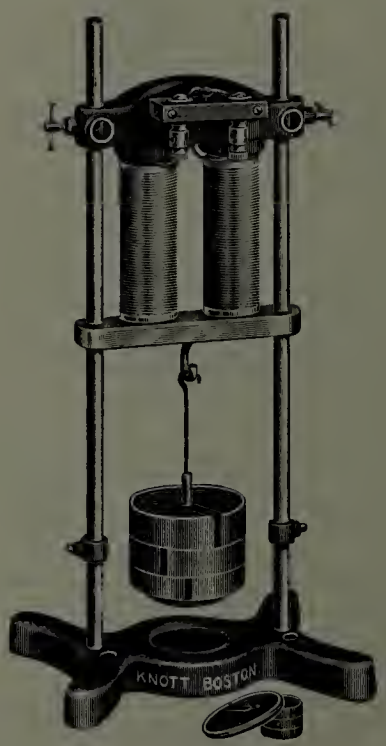
Horizontal Position

No. 92–195

92–195 **IMPROVED MOUNTED ELECTRO-MAGNET,** useful as a demonstration electro-magnet; also for remagnetizing. In this design mounted for use in the two positions above illustrated we offer not only a design capable of electro-magnetic study but also one inferior to none in appearance and utility.

This apparatus consists of two 6-inch U-shaped soft iron cores to the branches of which are attached two removable helices. This combination is mounted on a neatly finished support designed for use of the electro-magnet in two positions. Binding posts are provided for connections to battery. Actual tests give the sustaining power of this instrument of from 150 to 200 pounds.

Electro-magnet mounted as illustrated **$9.50**



No. 92–200

92–200 **ONE-HUNDRED-TEN-VOLT LIFTING MAGNET.** This magnet more nearly conforms to the conventional type with the important modification that it is designed to operate on a 110-volt direct current and will easily sustain a load of 300 pounds weight.

As will be noted from the illustration, the magnet is so mounted that it may be easily used in the form shown in the illustration or reversed so that the poles extend vertically upward or supported in a horizontal position with the poles extending outward.

This magnet will be found of particular value in connection with the important series of experiments on magnetic and diamagnetic materials.

Stops are provided for limiting the movement of the armature in order to avoid breakage.

Specifications, —

Net weight of magnet, without support, 10 lbs.

Height of the frame, 25 inches.

Diameter of core, 1 inch.

Size of winding, 4¾ × 1¾ inches.

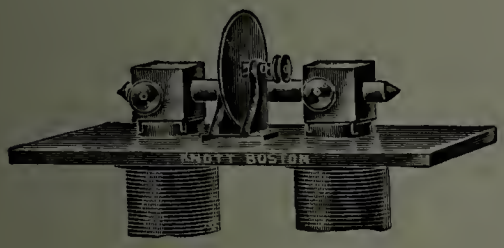
Resistance, 220 ohms.

Ampere consumption, 0.5 amp.

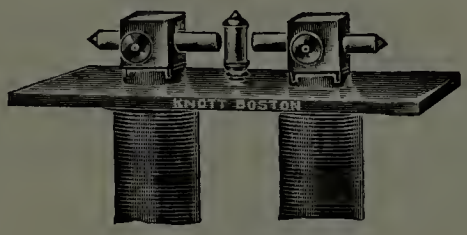
Voltage recommended, 110 volts.

Lifting power. 300 pounds, ... **16.00**

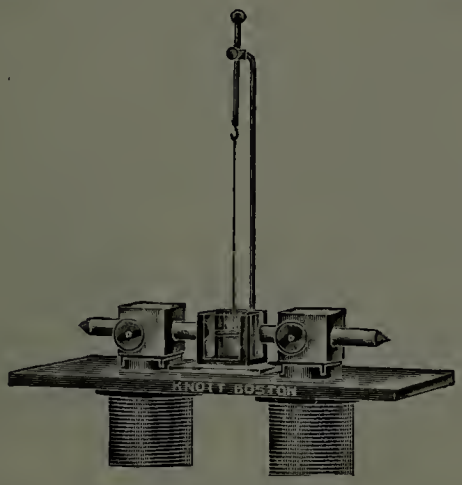
PARAMAGNETIC AND DIAMAGNETIC STUDY APPARATUS



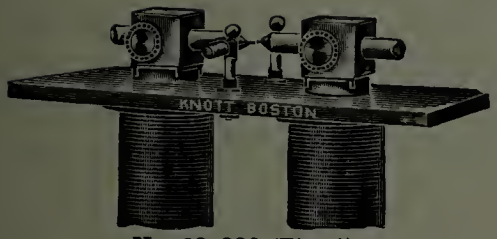
No. 92–220 (Fig. 1)



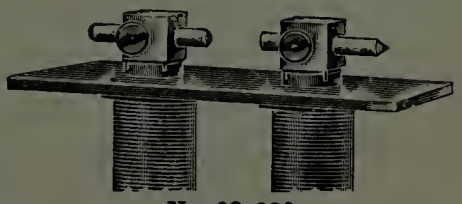
No. 92–220 (Fig. 2)



No. 92—220 (Fig. 3)



No. 92–220 (Fig. 4)



No. 92–220

92–220 PARAMAGNETIC AND DIAMAGNETIC STUDY OUTFIT for use with Magnet No. **92–200** for general electromagnetic study, but especially designed to facilitate the demonstration of paramagnetism and diamagnetism.

The outfit consists of special pole pieces for attachment to the pole faces of Magnet No. **92–200**, and the following additional accessories.

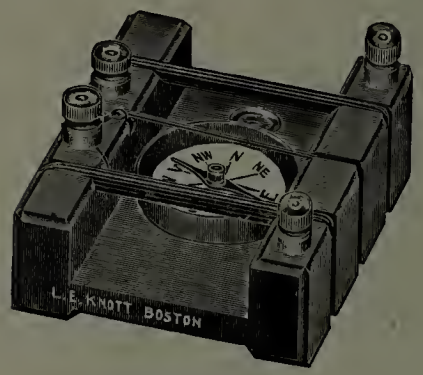
1. **Mounted Copper Disc** illustrating retarding and stopping of rotation due to the current set up in the disc.
2. **Mounted Copper Cylinder** illustrating the heating effects in a magnetic field, demonstrated by the boiling of ether placed in the cylinder.
3. **Mounted Cubical Vessel** and **Suspension System** for illustrating Diamagnetism and Paramagnetism, including ten different metal rods, — lead, silver, bismuth, nickel, copper, iron, zinc, tin, aluminum, and antimony, each with a small hook for suspension. In using the metals on suspension support the hollow cube is not necessary, as this cube is used to show the magnetization of ferric chloride solution.
4. **Insulation Points** with binding screws for illustrating diamagnetism of flames and the deflection of the auriole of electric discharges.

Outfit of accessories complete **$19.00**

92–225 PARAMAGNETIC AND DIAMAGNETIC STUDY APPARATUS. This outfit is complete for the study of paramagnetism and diamagnetism and for general electro-magnetic study. It consists of Magnet No. **92–200** and accessories No. **92–220.** It is listed complete for the convenience of teachers who do not already have Magnet No. **92–200** and who desire the complete equipment . **35.00**

ELECTRICAL MEASURING INSTRUMENTS

GALVANOSCOPES



No. 93–12

93–12 GALVANOSCOPE, after Millikan & Gale's "A Laboratory Course in Physics," pp. 80 to 100.

This instrument has three separate circuits, each with two binding posts for connections. One circuit is wound with twenty-five turns of No. 22 wire, another with one hundred turns of fine wire, and another with a single turn of coarse wire. Thus it may be seen that the sensibility of the instrument can be changed at will depending upon the number of turns used in circuit as well as on the position of the compass relative to the current bearing coil.

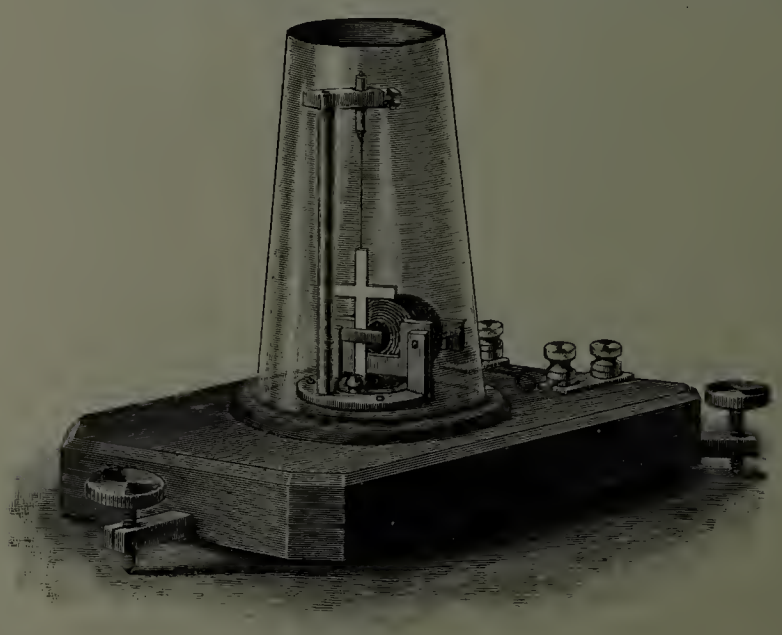
Complete as illustrated, but without compass **$1.20**

COMPASSES. See Section 81.

No. 93–20

ASTATIC GALVANOMETERS

93–20 ASTATIC GALVANOMETER. This instrument was designed according to the requirements of the National Physics Course, built on the close-coil type, with astatic system in which one needle moves between the coils and one above. Aluminum dial 3½ inches, windings of No. 18 copper wire, resistance approximately one ohm. The instrument is provided with three leveling screws and binding posts. A convenient and sensitive instrument where low voltage only is to be used **$3.50**

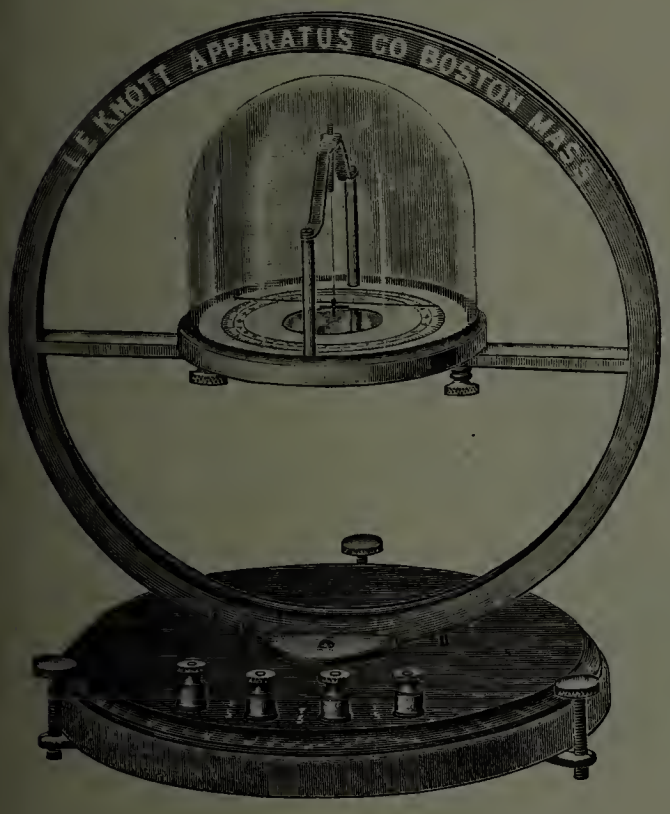


No. 93–30

93–30 TROWBRIDGE SENSITIVE GALVANOMETER. This instrument is constructed on the close-coil principle in which the magnet is suspended from a light aluminum vane hanging in front of the coil. Coils of varying resistances may be supplied if desired. The coil with which the instrument is furnished, is intended for Wheatstone Bridge work and other experiments where the voltage is exceedingly low. The end of the aluminum vane projects into a metal cup under the coil which, for purposes of making the instrument dead-beat, may be filled with glycerine, if desired. The actuating coil is clamped in metal clips and may be easily removed.

This instrument has the advantage over the conventional form of Astatic Galvanometer since all the parts are clearly exposed. The instrument is more nearly dead-beat and by use of an outside control magnet, for which the instrument is well adapted, a great variation in sensibility is obtained **4.25**

TANGENT GALVANOMETERS



No. 93–60

Nos. 93–40 to 93–50

93–40 **THE SIX-INCH TANGENT GALVANOMETER** (or **GALVANOSCOPE**), a Tangent Galvanometer of simple construction, coil of oxidized brass 6 inches in diameter, arranged with binding-posts which connect to 5, 10, and 15 turns respectively of No. 18 wire. Please note that all connections are exposed so that the student can very easily trace the direction of the current. This is an important feature in students' work. The compass used may be of varying sizes, brass or jewel bearing, any size of compass being held in the exact center of the coil by means of our double acting spring clips. With the short needle compass the instrument naturally conforms more nearly to the requirements of the Laws of Tangents.

This is a convenient instrument for such experiments as Tracing the Lines of Magnetic Force, rough experiments in Measurement by Substitution, and a large number of general experiments such as ordinarily given in the first year science courses. The educational value of this form of instrument we consider far greater than the cheap close-coil instruments sometimes offered. With brass-capped compass **$2.20**

93–44 **STUDENTS' SIX-INCH TANGENT GALVANOMETER,** with agate-bearing compass **3.00**

93–50 **STUDENTS' SIX-INCH TANGENT GALVANOMETER,** with large compass and pointer **3.65**

THE HARCOURT TWENTY-TWO CENTIMETER TANGENT GALVANOMETER

This Galvanometer is designed for High School use. It has all of the essentials of the higher-priced instruments. It is of substantial construction but without unnecessary finish.

We employ an aluminum ring 22 centimeters in diameter which, with a 2-centimeter magnet, enables the laws of the Tangent Galvanometer to be definitely determined. The coil is 6 millimeters wide, so that errors resulting from this source are reduced to a minimum. Provided with leveling screws and compass box 11 centimeters in diameter, mirror dial and glass dome. This compass box is easily removable by loosening two set screws shown on the cross bar. With the compass box removed the instrument is readily made use of in a variety of experiments on induction. The instrument is provided with four binding posts connecting consecutively to 5, 10, and 15 turns of wire.

93–60 **THE HARCOURT TWENTY-TWO CENTIMETER TANGENT GALVANOMETER,** with fiber suspended needle and long aluminum pointer and mirror dial **$7.15**

93–65 **THE HARCOURT TWENTY-TWO CENTIMETER TANGENT GALVANOMETER,** with jewel-bearing magnet and long aluminum pointer in place of the fiber suspension **7.15**

TANGENT GALVANOMETERS

No. 93–75

93–75 STANDARD TANGENT GALVANOMETER. This is a distinctly higher grade instrument than the preceding. All parts have been made with the greatest care. As will be noted from our illustration it is provided with a Thompson adjustable control magnet with both a vertical and horizontal motion. It slides on a post in a carefully adjustable sleeve. A coil 13 millimeters wide is mounted on a finished brass ring 20 centimeters in diameter. This ring is mounted on a substantial base to the binding posts of which are carried the terminals of the coil.

The suspension system consists of a needle 15 millimeters long, suspended by fiber and provided with a convenient and satisfactory lift. The needle is protected by a box 12½ centimeters in diameter, provided with silvered engine-divided dial.

To meet the conditions of the greatest variety of experiments in practical laboratory work and also for determining the constant in a tangent galvanometer the windings have been carefully worked out as follows: —

3 turns of coarse wire connected to posts 1 and 2, wound clock-wise.

12 turns of coarse wire connected to posts 2 and 3, wound counter clock-wise, giving between posts 2 and 3, nine turns of coarse wire wound counter clock-wise.

320 turns of fine wire connected to posts 1 and 4, wound clock-wise. This coil is especially designed for determining the constant of a tangent galvanometer.

We have no hesitancy in claiming that this is one of the most carefully designed and scientifically proportioned galvanometers on the market **$33.00**

93–80 ——, same as above, but mounted on polished hardwood base in place of the tripod **22.50**

D'ARSONVAL GALVANOMETERS

The enormous increase in the use of electric current and the employment of iron in the construction of buildings make necessary the use of a type of measuring instrument which is not affected by outside magnetic influences. Of the different types devised the only one which survives by its general fitness is the Deprez-D'Arsonval, usually called the D'Arsonval Galvanometer, but which was first used by Thompson in his work on the Atlantic cable.

So free is this instrument from magnetic influences that it can be used close to large dynamos and motors. Owing to the method of suspension, the powerful magnetic moment exerted by its moving coil, and the great restoring force of the suspension, it is singularly free from the effects of vibration as compared with the older types of instruments. In short, a well-designed D'Arsonval Galvanometer is almost the ideal instrument for indicating and measuring electric currents in laboratories devoted to either educational work or to technical research.

Development in the D'Arsonval Galvanometer construction has made such rapid progress that exceedingly sensitive instruments, if correctly designed, are now practical for placing in the students' hands.

As will be noted from the illustrations on the following pages, we use the D'Arsonval principle on instruments designed both for lecture table demonstration and for students' individual laboratory work.

MEASURE OF SENSIBILITY. In the rating of all of our galvanometers we use the "megohm standard," recognized by the best European manufacturers as the one which conveys most intelligibly the information the user should have at hand.

MAGNET SYSTEM. Wherever practical we use the laminated magnet for the reason that it gives not only greater magnetic pull per unit area, but more particularly because of its ability to hold its magnetic strength with less loss from rough usage. It will also be noted that we use the closed circuit magnet because of its well-recognized quality of greater strength and permanency. This form of magnet has not heretofore been largely used because of the greater expense involved in properly magnetizing it. The ampere turn method which we use has been recognized as the only reliable one for magnetizing a magnet designed for use in galvanometer work. The expense, however, involved in this method, particularly in the closed circuit type of magnet, is such as heretofore to have discouraged many manufacturers from using this type of magnet.

SUSPENSION SYSTEM. We have designed a form of suspension system which is used in practically all of our D'Arsonval types of instruments, both lecture table and students' type. In this form the entire suspension system can very easily be removed from the magnets, placed on the table in an easily accessible position for the ready interchange of suspension. This will be found of convenience at times, notwithstanding the fact that the liability of breakage of the suspension has been greatly reduced. We supply suspension ribbons and coils with connecting strips which can be attached almost instantly without the aid of either a screw driver or soldering copper.

COILS. All coils, unless otherwise specified, are of the dead-beat form, but for Capacity and Induction work we supply, when ordered, coils especially adapted to this work for either type of instrument.

METHOD OF READING. The method of reading employed is such in every case as is best adapted to the particular type of instrument and the use to which it is to be put. On the various types we use the several different systems as here specified:

A POINTER, reading on either the vertical or horizontal scale.

MIRROR READING, employing the back target fiducial mark, making it possible to use a front opening wide enough for both eyes to be used in their normal position without errors of parallax.

THE MIRROR METHOD with the small peek hole front target, designed more particularly for advanced students.

TELESCOPE READING. All of our instruments, except the inexpensive students' types Nos. **93–198** and **93–200,** are supplied with mirrors. The regular reading device may be very easily removed and the instrument used as a telescope reading instrument.

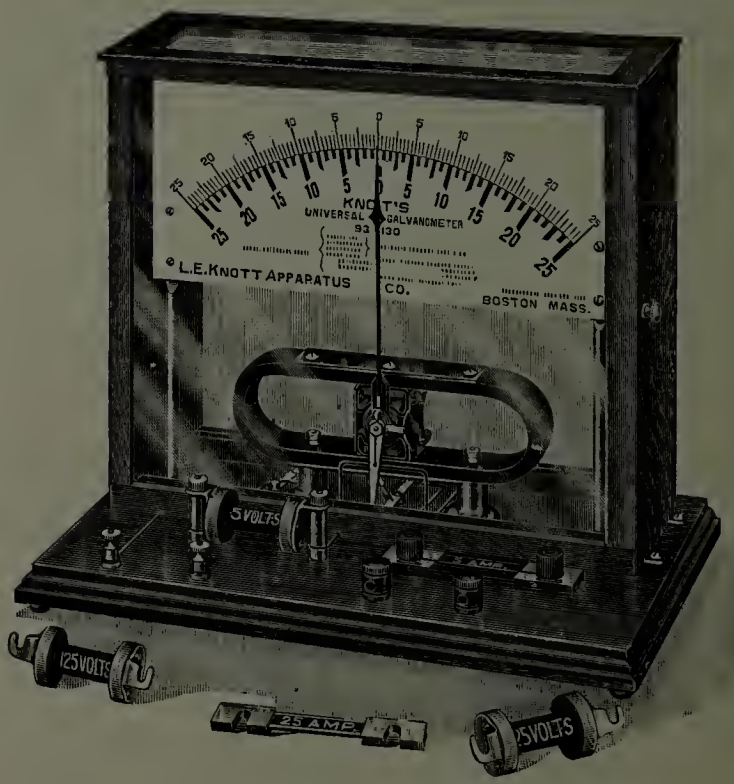
THE TELESCOPE MOUNTING and **BRACKET,** illustrated under No. **93–245,** is designed of such size as to take any of our standard types of instruments.

LECTURE TABLE GALVANOMETERS

No. 93-130

UNIVERSAL LECTURE TABLE GALVANOMETER

EIGHT INSTRUMENTS IN ONE



Patent Pending

Designed for a practical and reliable Lecture Table instrument covering a **wide range** and giving one division deflection on .002 of a volt.

The movement is of the commercial D'Arsonval type but slightly modified; the moving coil adjusted for one ohm resistance, making it possible to supply at any time detachable and interchangeable shunts or resistances of any desired range.

EIGHT INSTRUMENTS IN ONE

The following eight instruments are therefore available in this one outfit:

1. **A Galvanometer** in which one space deflection means .002 of an ampere or .002 of a volt.
2. **A Millivoltmeter** in which the entire scale deflection means 25 millivolts in ½ millivolt divisions.
3. **A Milliamperemeter** in which the entire scale deflection means 25 milliamperes in ½ milliampere divisions.
4. **A Voltmeter** range of 0–5 volts in 1/10 volt divisions.
5. **A Voltmeter** range of 0–25 volts in ½ volt divisions.
6. **A Voltmeter** range of 0–125 volts in 2½ volt divisions.
7. **An Amperemeter** range of 0–5 amperes in 1/10 ampere divisions.
8. **An Amperemeter** range of 0–25 amperes in ½ ampere divisions.

DIAL. The dial is twelve inches long with wide and clearly indicated divisions. Note below the reproduction of the scale about 1/5 size. It may easily be read from any part of the lecture room.

FOR THE INSTRUCTOR'S CONVENIENCE the back of the dial carries a scale with full and explicit directions for connecting. On the base is a protecting switch to avoid accidentally burning out the coil by a mis-connection.

A NEW METHOD OF CONNECTING SHUNTS, which automatically insures the same contact pressure on both the shunt and coil circuit. This eliminates all liability of contact error in the shunt system.

UNIVERSAL FEATURES. We have produced an instrument in which both the educational and commercial features have been carefully considered and economically solved.

ACCURACY. The calibration is done in connection with the best standard commercial instruments. All parts are carefully constructed. The magnets are aged by the standard aging method. The jewel bearings are best quality sapphire. In short, we believe this instrument to be the best electrically, mechanically, and educationally, that has ever been offered.

93–130 UNIVERSAL LECTURE TABLE GALVANOMETER, complete with full set of Shunts and Resistances giving ranges previously listed **$35.00**

EXTRA SHUNTS AND RESISTANCES. Should an instrument of any other range than that already provided for be desired, the proper shunts and resistances will be furnished on special order at the net price each of **2.50**

L. E. KNOTT APPARATUS COMPANY
HARCOURT STREET,
BOSTON, MASS.

GENTLEMEN, — Let me add that your Galvanometer has been a most thoroughly satisfactory instrument and wonderfully sensitive.

Very sincerely yours,
(Signed) HAROLD B. REED,
Instructor in Physics,
East High School,
Cleveland, Ohio.

February 21, 1912.

GENTLEMEN, — Your Lecture Table Galvanometer has been a great help in teaching the subject of current electricity to mixed classes. The fact that all connections and moving parts are plainly in view, and the scale large and open, and the ranges large make it an ideal educational instrument.

The use of the ammeter shunts and of the switch shunt and their effects on the deflection of the needle, tend to clear up the subject of divided circuits.

I have it before my classes during our study of current electricity and use it constantly. It is a usable and extremely satisfactory instrument and one that should be in every Physics lecture room.

Very truly,
(Signed) ERNEST R. SMITH,
North High School,
Syracuse, N. Y.

March 15, 1912.

GENTLEMEN, — The Lecture Table Galvanometer has been received and in good condition. Needless to say I am much pleased with it and will make excellent use of it. In fact, it is just about the device I have been looking for and it is probable that I shall order a second unit of this kind for our laboratory, next year.

Very truly yours,
(Signed) WILLIAM H. BROWNE, JR.,
N. C. Coll. of Agriculture & Mechanic Arts,
West Raleigh, N. C.

March 28, 1912.

No. 93–145

93–145 LECTURE TABLE GALVANOMETER. As will be noted from the cut, this instrument is mounted vertically, of sufficient height for lecture table use. The scale is large and open so as to be seen across the lecture room, the pointer of aluminum, the bearings jewel, the moving system a 1½-inch magnet. The windings are in three sections, — coarse, medium, and fine wire of varying resistances and varying ranges.

This is not designed for an instrument of high sensibility, but rather to cover the widest range feasible to attain in an inexpensive lecture table instrument.

It will be found well adapted for such experiments as polarization, the study of the relative strength of cells either in groups or in multiple, experiments on induction taken in the larger way, and many other experiments which will suggest themselves as adapted to this range of instrument **$6.50**

No. 93–155

93–155 THE LAMPRA PROJECTION GALVANOMETER. This galvanometer is of the same genera type as used in France and Germany in the early days of the pivotal bearing D'Arsonval. It has, however, been greatly improved by taking advantage of more recent developments in galvanometer construction.

As will be noted from the illustration, it is especially adapted for projection work, the scale chamber being of the regulation slide holder size with glass both sides of the indicator. The galvanometer movement is encased in a compact box mounted so as to give adequate adjustment for any form of Projection Lantern, the indicator moving over an arbitrary scale. The entire instrument, including the indicator chamber, is sealed for proper protection against dust and air currents. A most effective and convenient demonstration instrument for lantern work **$22.00**

No. 93–175

THE IMPROVED LAMINATED MAGNET

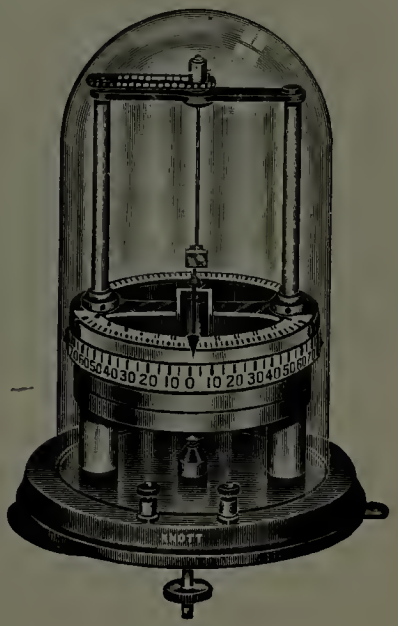
LECTURE TABLE GALVANOMETER

30 MEGOHM SENSIBILITY

MAGNETS. As the illustration shows, this instrument is made up of four horizontal magnets. Because of the form of the magnet, and the fact that the whole system is laminated, we are able to produce a magnetic pole of a strength at least five times that used in any other Lecture Table Galvanometer on the market.

COIL. We have employed the cylindrical, close-wound coil recognized by instrument makers the world over as being the only form in which the deflections bear the proper relation to the current strength. The value of such a coil in a Lecture Table Galvanometer is of especial consideration, as both the lecturer and the students are able to recognize, from the amount of deflection, the relative amperage passing through the coil.

SCALE. Our instrument is designed or a 60 degree deflection either side of zero, making a total of 120 degrees. Note, also, that the instrument is provided with four scales and double pointer. A vertical scale on both sides of the instrument with coarse divisions, is especially intended for students' readings. A horizontal finely divided scale on top of the magnet on both front and back is of value to the instructor or students desiring to make closer readings than can easily be made on the coarse scale intended for wide range work.



No. 93–175
Patent Pending

NON-PARALLAX READING DEVICE. As will be noted from the illustration, the vertical scale is offset in such a way that the large triangular pointer does not over-lap the scale, but is in the same line with it, making it possible to use the so-called "straight line method of reading," which avoids all errors of parallax.

ZERO ADJUSTMENT. A convenient and most desirable method of adjusting the pointer to zero has been worked out, using the chain and sprocket, one sprocket being mounted on the upper end of the vertical shaft passing down the inside of the supporting post. On the other end of this shaft is a milled-edge disc projecting slightly beyond the base to the left in a most convenient and accessible position. With this arrangement the needle is quickly and easily adjusted to zero without raising the glass dome.

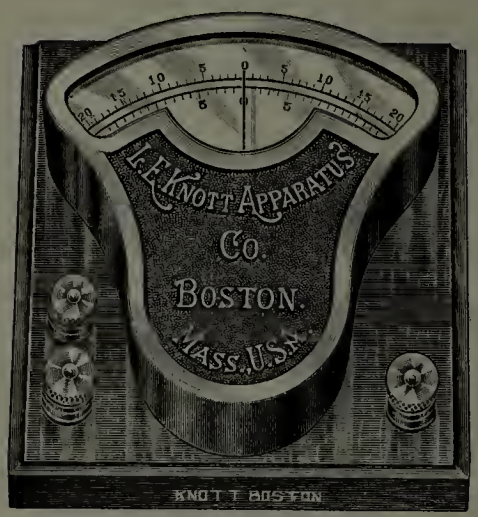
COIL LIFT. For safety in shipping and in handling, the coil is easily raised from the suspension ribbon by a knob conveniently located on the base, on the right of the instrument.

METHOD OF ATTACHING SUSPENSION RIBBONS. In D'Arsonval Galvanometers, using the steel or phosphor-bronze ribbon, there is some danger of breaking the suspension, owing to carelessness in handling the instrument before the coil is raised to shipping position. As will be noted in the diagram, the upper portion of the coil terminates in a horizontal, close-wound spiral between the turns of which the suspension plate is inserted. Should, therefore, breakage accidentally occur, we can furnish a new ribbon with the suspension plates attached, which the customer can insert quickly and easily without the use of a screw driver or soldering copper. This feature makes this lecture table instrument, as well as our complete line of D'Arsonval Galvanometers, practical for use by the most inexperienced.

SENSIBILITY. We have thought it best to adjust this galvanometer to a considerably higher sensibility than is ordinarily furnished for lecture table work, as it permits an entirely new field of experiments not possible with the instruments usually supplied. In case, however, it is desired to reduce the sensibility, this can be very easily done by inserting a coil in the form of a shunt. Special coils for this work will be supplied if desired. While it is perfectly feasible, with our methods of construction, to put out an instrument of very much higher sensibility, it has seemed to us that 30 megohms would meet the greatest variety of conditions. This instrument, therefore, will be adjusted to approximately this sensibility.

THE IMPROVED LAMINATED MAGNET LECTURE TABLE GALVANOMETER, complete as above illustrated **$15.00**

LABORATORY D'ARSONVAL GALVANOMETERS

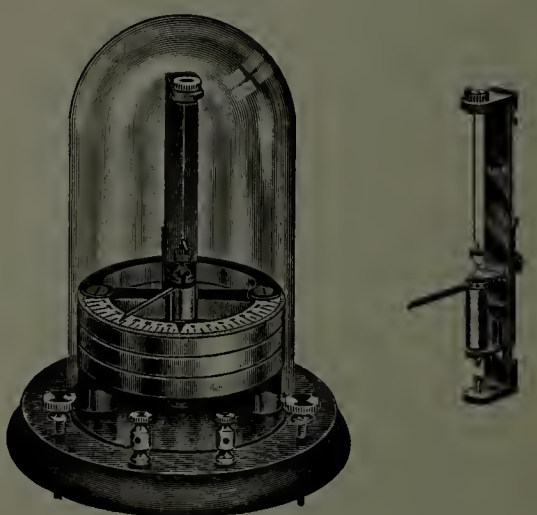


No. 93–195

93–195 **HORIZONTAL GALVANOMETER,** D'Arsonval movement, jewel bearing, 0 center. This is a commercial type of instrument in horizontal or laboratory form. The range is such as to make it of the greatest value in general laboratory practice. Quick action, quick reading, adapted to a wide range of experiments, such as Induction, Polarization of Cells, Measurements of the Wheatstone Bridge, where an accuracy equal to ½ millimeter on the bridge is considered sufficient.

Owing to the form of the pole pieces the scale is proportional to the amount of current going through, thus giving the instrument a range of usefulness far greater than its sensibility would indicate.

Jewel bearing, mahogany base, aluminum case. A substantial, convenient, well-constructed instrument of the D'Arsonval type **$7.50**



No. 93–200
Patent Pending

93–198 **HARCOURT IMPROVED D'ARSONVAL GALVANOMETER** similar to No. **93–200,** but single magnet type. Designed particularly for "Laboratory Physics" by Millikan, Gale and Bishop. **$2.75**

93–200 **THE TRIPLE LAMINATED MAGNET HIGH SCHOOL GALVANOMETER.** The simplicity of construction and ease of use in a students' laboratory galvanometer are quite as essential as sensibility. In the instrument above illustrated, simplicity and ease of operation are obtained to an extent which a few years ago was considered impossible. The simplicity of this design will appeal to the practical laboratory instructor. Its sensibility is well within the range which such instruments are designed to meet.

Features. The triple laminated magnet gives greater magnetic pull, enabling heavier ribbon suspensions to be used, thus decreasing the liability of breakage.

As will be noted, the **coil** is of the close-wound type, the same as employed in our Galvanometer No. **93–210,** a form of peculiar value in an instrument designed for individual laboratory work, as the student should be able to determine from the amount of deflection, the approximate voltage and amperage to which the instrument is subjected.

The entire **suspension system** may be removed by loosening a single screw. Should the suspension ribbon be accidentally broken, a new one may be readily inserted in a few seconds by the student. No soldering copper or screw driver is required.

The **zero adjustment** is readily made by turning the metal button at the top of the suspension post.

A most efficient **coil lift** is provided which raises the coil from its suspension and clamps it rigidly in position, ready for rough handling and for shipping.

For convenience the **readings** are taken by a pointer moving over a 3½-inch horizontal dial graduated in degrees.

Sensibility. The rating, according to the standard method, is about thirty megohms, although the construction of the instrument is such as to permit of a higher sensibility should it be deemed desirable to use such in the work for which this instrument was designed.

Complete **4.60**

93–210 THE LAMINATED VERTICAL MAGNET GALVANOMETER (The One Ohm per Megohm). A laboratory galvanometer designed with special reference to the needs of the individual student will be fully appreciated. It has been our purpose to construct an instrument which can be easily set up, adjusted and kept in adjustment and one in which all working parts are constantly in view.

No. 93–210
Patent Pending

The **unit suspension system** which has been worked out according to the lines noted in the detailed illustration carries the coil, upper and lower suspension, zero adjustment and lift, all constituting a single unit attached to the back brass plate. In setting up the instrument this plate is held rigidly between the magnets by means of four screws, removing the thumb nuts from which removes the entire system for inserting Ballistic Coils, coils of high or low resistance, or for replacing broken suspensions.

Our **suspensions** are supplied with metal terminals which are easily slipped between the convolutions of the phosphor-bronze spiral with which the coil is supplied, insuring a perfect electrical and mechanical contact. The lower suspension, which has heretofore been replaceable only by a person with much experience, is now even more easily handled than the upper suspension, as each spiral is sent out contained in a sealed glass tube, the terminals passing through the upper and lower ends of the tube. After the coil is set in place and the adjustment made, the seal is cut away; the galvanometer is then ready to use, all without touching the spiral with either tools or fingers.

We have used on this instrument the modified form of the **reading device** used on our original students' D'Arsonval Galvanometer with the very important modification that the user now looks in an inclined position, permitting the galvanometer to be used on the surface of the table and avoiding the necessity of either getting down to the level of the mirror, or of raising the galvanometer to the height of the eye.

The **sensibility** of this instrument is equal to all requirements for laboratory work. As ordinarily sent out, these instruments are adjusted for 70 megohms sensibility. A higher sensibility than this is readily obtainable if there be adequate demand for it.

POINTS OF ADVANTAGE

The **resistance** is approximately the same as the sensibility in megohms, — one ohm per megohm.

The unit suspension system.

The visibility of all parts.

The readiness of assembling and adjustment.

The ease of replacing broken suspensions.

The magnetic strength and permeability due to the laminated magnet.

A method of reading which is practical in the hands of the most inexperienced.

The zero adjustment which is effective and easily handled.

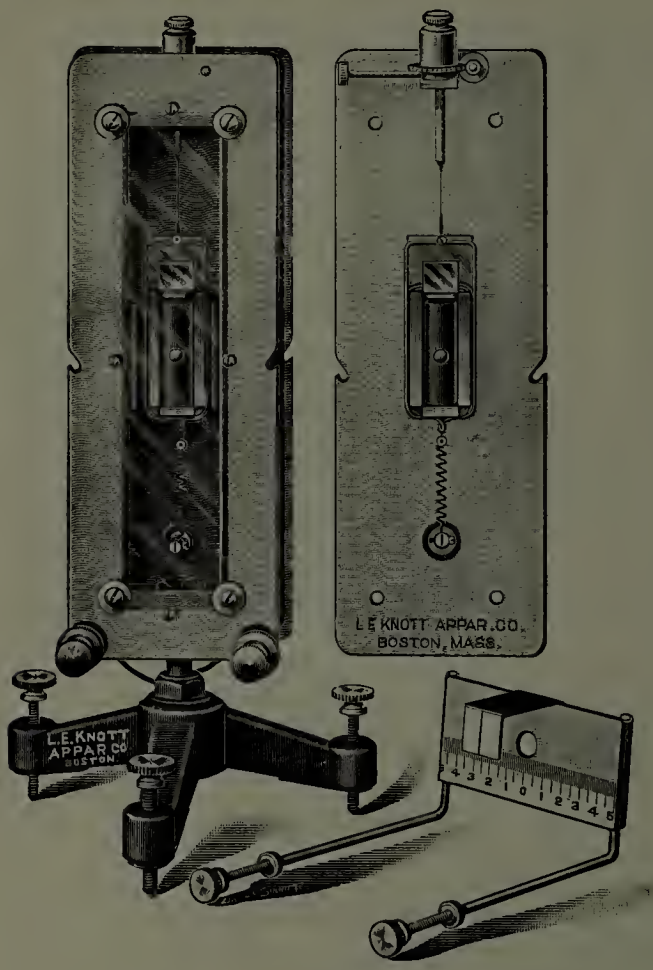
The coil lift, conveniently located and instantly operated by a single movement.

A sensibility of 70 megohms, being substantially four times that obtained in any other students' type of instrument.

Unusual low resistance, — about 70 ohms. **$6.45**

93–215 BALLISTIC COIL. The above instrument, No. **93–210,** is especially adapted for the use of Ballistic Coils in Capacity and Self-Induction experiments. The most convenient method of inserting the coils is to obtain a unit suspension system with the Ballistic Coil attached. The new system can then be inserted very easily.

Unit Ballistic System complete ready for attaching **6.00**



No. 93–220

93–220 TWO HUNDRED MEGOHM D'ARSONVAL GALVANOMETER, an instrument of high sensibility for use with either scale or telescope reading.

The method of suspending the coil system will be found of the greatest practical value; the entire system may be taken out by loosening the set screws and removing the back plate, as noted in the illustration. Broken suspensions may be very easily replaced.

SENSIBILITY. These instruments are approximately 200 megohms sensibility, of quick movement and practically dead-beat.

METHOD OF READING. The method of reading is effective, overcoming errors of parallax. The reading scale may be easily removed by loosening two thumb nuts. The instrument is then well adapted for telescope reading. When it is desired to use this as a wall form instrument for telescope reading, we recommend telescope, scale, mounting and bracket. (See Index) **$15.00**

93–230 SIX HUNDRED MEGOHM SELF-LEVELING D'ARSONVAL GALVANOMETER, either wall or table type (see illustration next page). A galvanometer for advanced laboratory work which is both self-centering and self-leveling, used either as a wall or table instrument. The entire instrument is hung from universal gimbals so that both magnet and coil are always in correct relation.

As a wall instrument. This has a great advantage in overcoming the difficulties usually encountered in fastening an instrument to the wall and securing the proper level.

As a table instrument. The advantages are even more pronounced, as the self-centering permits absolute freedom of movement from one portion of the table to another, with assurance that the instrument will instantly assume a level and be ready for use.

Telescope mounting and bracket. The supporting stand for the galvanometer was designed to fit our Universal Galvanometer and Telescope Support No. **93–240.** When the two instruments are used together, a most convenient and effective galvanometer outfit is obtained.

Reading Device. A two-color scale mounted in a sliding socket for adjusting to zero, telescope on an adjustable arm with leveling screws which may be removed when not in use.

The Achromatic Telescope, especially designed for galvanometer work.

Magnet System. By our method of magnet construction we secure far greater strength and permanency than are obtained in any other galvanometer magnet on the market. The concentration of the lines of force to meet the size and form of the coil has been the subject of much careful study.

No. 93–230

Coil System. A removable coil system insures easy access to all delicate parts and the ready replacement of broken suspensions. Extra coil systems designed for special work supplied on request.

Sensibility. As ordinarily furnished, the instrument is supplied with a coil of 400 ohms resistance, giving a sensibility of over 600 megohms, the range which has met with the greatest favor.

The Mirror is optically plane, ½ x ⅜ inch.

Suspensions. By carefully adjusting the weight of the coil to the size of the phosphor-bronze suspension, we have practically eliminated the zero set, but for those who prefer the steel suspension this will be furnished.

Complete as illustrated $32.00

93–232 **EXTRA COILS,** either Ballistic, low, or high resistance as specified, are furnished for use with the above instrument . . . . . Each 7.50

93–235 **RADIO MICROMETER.** In scientific work the Radio Micrometer has long been recognized as not only the most sensitive, but the most reliable heat indicator produced. In putting this sensitive instrument into practical form, we have used the fundamental parts of the D'Arsonval Galvanometer, — magnet system, mirror and reading device, but with the moving coil replaced by the most sensitive thermo-electric couple which it is possible to construct, with a suspension to hold the couple in position, and designed to introduce the least possible amount of restraining influence.

No. 93–235

Sensibility. In radio-micrometer work, the candle flame at definite distance has been found a convenient standard. It is possible with our instrument to detect an amount of heat equal to that received from a candle flame at a distance of 50 feet, giving clearly indicated readings on the dial.

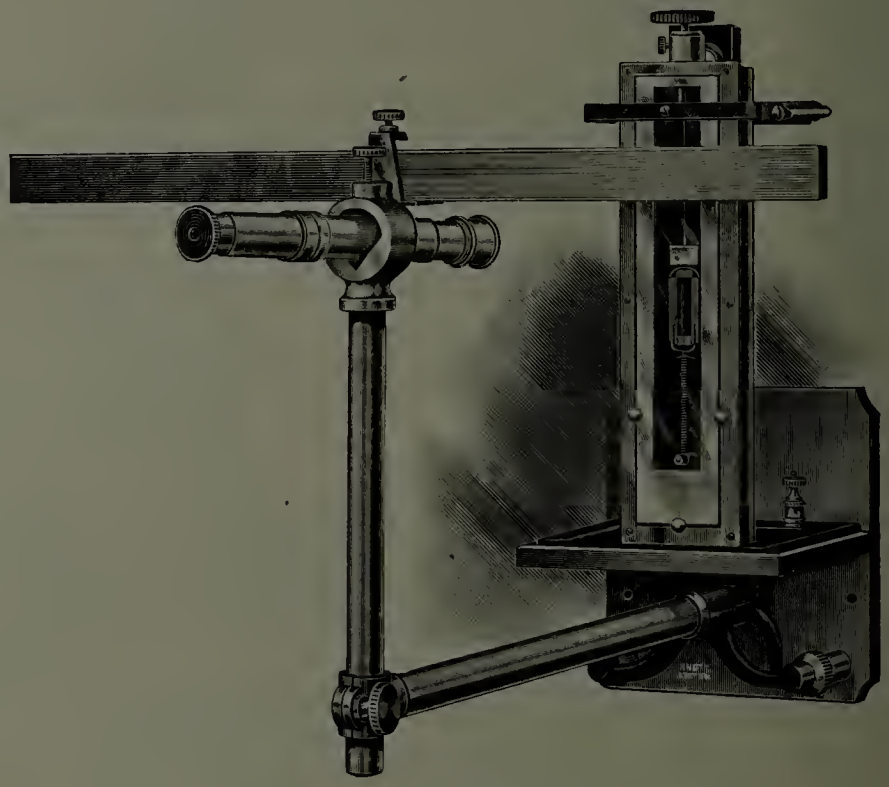
Method of Reading. With many radio-micrometers previously constructed, the readings must be taken with the telescope method owing to the fact that the deflections caused by the heat of the body make it necessary for the observer to remain at a considerable distance. Much of this difficulty has been overcome by our method of introducing heat to the thermo system. The directing horn is mounted on a movable ring so that the heat may be taken either from one side of the instrument or the other, but not from the front where the observer would naturally stand. The moving system being provided with a mirror and the close-reading scales easily removable, the telescope method of reading will be found in some cases more satisfactory.

Complete instructions for use will be furnished with each instrument.

Complete as illustrated $15.00

UNIVERSAL GALVANOMETER WALL-BRACKET AND TELESCOPE SCALE

ADAPTED TO ANY TYPE OF INSTRUMENT

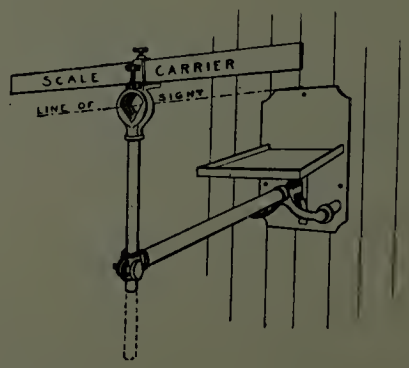


No. 93–245

93–240 GALVANOMETER WALL-BRACKET and **TELESCOPE SCALE.** Heretofore sensitive galvanometers have been attached rigidly to the wall, it being necessary to level them with the greatest care. When once attached and adjusted, the galvanometer is allowed to remain on the wall permanently.

Our rigid wall shelf for galvanometer work, carrying the telescope arm and scale, gives a method of using galvanometers much more satisfactory than has ever before been offered. It was especially designed for use with the self-centering instrument No. **93–230,** although any of our D'Arsonval instruments may be used on it. For lecture table demonstration this shelf will be found of especial service. For this work we recommend the use of the bracket only, the light being supplied from the Liliputian Lamp, No. **70–125.**

Wall Bracket, Telescope and Scale **$16.50**

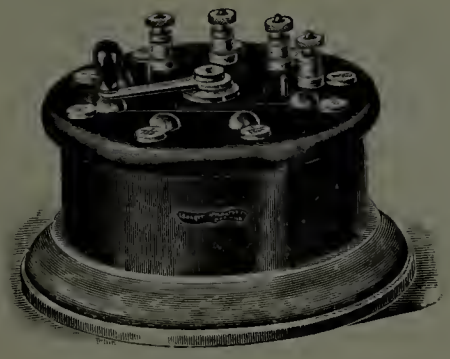


93–242 GALVANOMETER WALL-BRACKET only, without Telescope and Scale **$9.50**

93–245 GALVANOMETER WALL-BRACKET, TELESCOPE and **SCALE** together with No. **93–230 SELF-LEVELING D'ARSONVAL GALVANOMETER** complete as illustrated **48.50**

TELESCOPE. See No. **93–480.**

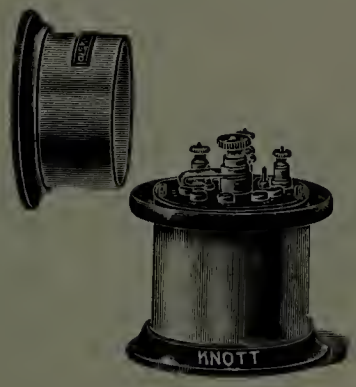
SHUNTS



No. 93–350

93–350 **ELEMENTARY AYRTON UNIVERSAL SHUNT.** In using a galvanometer of high sensibility it is necessary both for convenience and for protection of the galvanometer to use some device for reducing the strength of the current through the galvanometer. Separate shunts of the proper resistance may be used to bring the deflection down within the limit of the scale, but where it is desirable to send through the galvanometer at different times several different proportions of the main current the separate shunts become inconvenient. The instrument above illustrated provides in compact form a means of sending small or large fractions of the main current through the galvanometer, merely by a movement of the contact arm. This shunt is suitable for galvanometers with ranges from 50 to 500 ohms resistance.

Instrument is constructed with the greatest care, coils are accurately tested before shipment, and all parts are handsomely and durably finished **$7.50**



No. 93–360

93–360 **UNIVERSAL SHUNT.** A great advantage of this shunt over the one preceding is that it can be used with a ballistic galvanometer as well as with a dead-beat instrument. The instrument above illustrated has all the advantages of a universal form and in addition has the latest improved sliding contact which replaces the less convenient plug arrangement. The contact resistance is very low, although this is not a matter of great importance in the ordinary use of the instrument, as the contact resistance does not enter the galvanometer circuit proper. The circuit arrangements in our instrument are so arranged that the resistance coils are also available as a "drop wire," or simple potentiometer for subdividing a potential difference.

This instrument has received the most painstaking care in its construction as well as design. To protect the ebonite top from air, dust, and sunlight, thus preserving its insulating properties, a brass cover with mahogany top similar in style to the box is provided. It lifts clear away from the box on loosening a bayonet catch and is laid aside while the shunt is in use.

	a	b	c
Total Resistance	10,000	20,000	100,000 ohms
Each	**$28.50**	**38.00**	**62.00**

93–370 **UNIVERSAL SHUNT,** similar to above, but without cover.

	a	b	c
Total Resistance	10,000	20,000	100,000 ohms
Each	**$25.00**	**34.50**	**58.50**

GALVANOMETER ACCESSORIES

93–400 **PLANE GALVANOMETER MIRROR,** optically plane, diameter ½ inch **$1.00**

93–402 **ONE-METER CONCAVE GALVANOMETER MIRROR,** one-meter focus, diameter ½ inch . **1.25**

93–405 **TWO-METER CONCAVE GALVANOMETER MIRROR,** two-meters focus, diameter ½ inch . **1.45**

93–415 **NICKEL SUSPENSION FILAMENTS.** Owing to freedom from oxidation, high fusing point, and the ability to draw it to a fineness suitable for suspensions, nickel as a suspension filament has come into considerable favor.

	a	b	c	d	e
Diameter	.001	.0015	.002	.003	.004 inch
Per Foot	**$0.45**	**.40**	**.30**	**.25**	**.20**

93–425 **PHOSPHOR-BRONZE FILAMENTS.** Phosphor-bronze has been used with success as suspensions in the highest grade electrical instruments. Owing to its great tensile strength and non-magnetic qualities, it is of special advantage where high sensibility is desired.

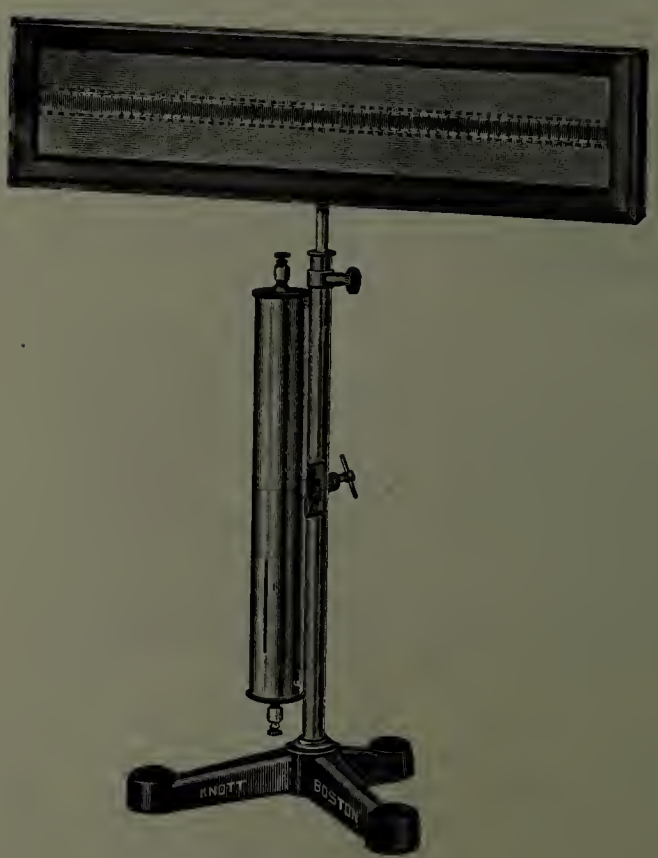
	a	b	c	d	e
Diameter	.001	.0015	.002	.003	.004 inch
Per Foot	**$0.45**	**.40**	**.30**	**.25**	**.20**

93–435 **STEEL SUSPENSION FILAMENTS.** Steel, as a suspension, is free from "set" and has great tensile strength.

	a	b	c	d	e
Diameter	.001	.0015	.002	.003	.004 inch
Per Foot	**$0.40**	**.35**	**.30**	**.25**	**.20**

93–445 **WOLLASTON WIRES,** the finest size of platinum wire filament; the wire before drawing, is enclosed in a silver sheath and is drawn through a jewel gauge (according to Wollaston) until the smallest size is obtained. The silver film that still remains must be removed chemically before the wires are used.

	a	b	c
Diameter of Platinum Core	.00006	.00008	.0001 inch
Approximate External Diameter	.006	.008	.0036 inch
Per Foot	**$1.25**	**1.00**	**1.00**

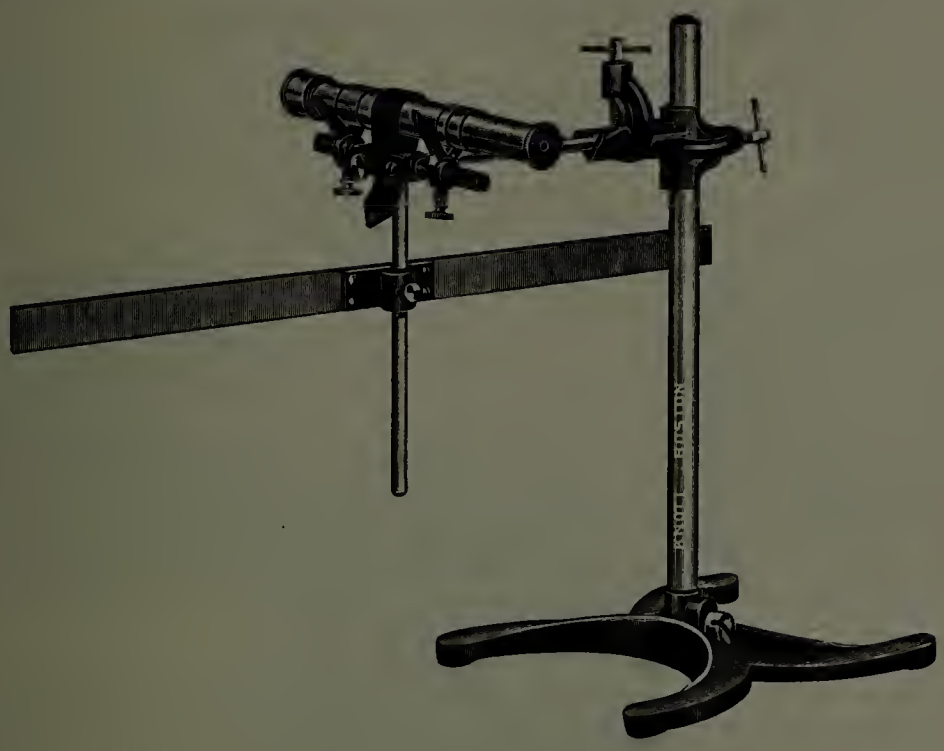


No. 93–460

93–460 **DIRECT READING ADJUSTABLY MOUNTED LAMP AND SCALE, "Lin-o-Lite" Lamp, Opalescent Screen,** for use with any reflecting galvanometer to give direct readings of the movement of the coil.

In the design above illustrated, we mount a single filament incandescent light within a cylindrical tube, the glowing filament showing through only a small opening in the cylinder. This cylinder is provided with a clamp for attachment to the supporting rod of the stand on which it is readily adjustable. The opalescent screen is mounted in a frame which is provided with a rod telescoping into the supporting rod of the stand. This screen has a scale across its entire length with long centimeter divisions and shorter millimeter divisions. This scale reads both ways from zero in the center. All parts of this apparatus are carefully made and the instrument has been of great utility in the many laboratories where it has been adopted.

Complete as illustrated **$11.25**



MOUNTED READING TELESCOPE AND SCALE

The only distinctive items illustrated above and not elsewhere listed are:

93–470 **READING TELESCOPE SCALE.** This scale is printed on glazed bristol board, 50 centimeters long, graduated in long centimeter divisions with shorter millimeter divisions either side from zero at the center, figures inverted. This scale is mounted on a hardwood strip provided with clamp for attachment to any 10-millimeter rod **$1.40**

93–480 **READING TELESCOPE WITH CROSS HAIRS,** objective 18 millimeters diameter, focus ½ to one meter, sliding tube focusing adjustment. This telescope is carefully constructed of the best obtainable material, the optical parts having been calculated to a nicety. The tubes are beautifully polished and lacquered and the objective is furnished with a brass cap. This telescope is especially designed for use in electrical measurements, but may be used equally as well in experiments on determining the magnifying power of a telescope **6.00**

Other apparatus illustrated above, and listed elsewhere is as follows:

5–242	**HARCOURT SPECIAL H-BASE,** for 19-millimeter rod . .	**$1.00**
5–20b	**SUPPORT ROD,** 19 millimeters diameter	**.52**
5–770	**HARCOURT RIGHT ANGLE CLAMP**	**.95**
5–920	**TELESCOPE CLAMP**	**2.45**
5–10b	**SUPPORT ROD,** 10 millimeters diameter	**.18**

70–110 **ELECTRIC LAMP,** table size, adjustable from 12 to 18 inches, made of polished brass, nickel-plated. Complete as illustrated in Section 70 . . . . . **9.75**

70–112 **GAS LAMP,** similar to above, but arranged for burning illuminating gas. Complete with Argand Burner and six feet of rubber tubing, with goose-neck connection, stand adjustable from 12 to 18 inches. **9.75**

70–115 **KEROSENE LAMP,** similar to above, but arranged with reservoir for oil. Complete **9.75**

For **LILIPUTIAN PROJECTION LAMP,** highly recommended as a source of light for galvanometer work, see page **241.**

D'ARSONVAL TYPE AMMETERS AND VOLTMETERS DOUBLE RANGE

No. 93–525

This Double Range D'Arsonval line of instruments is offered as a distinctively higher grade line than those which have been commonly used by students in laboratory practice. The D'Arsonval movement, the aging of the magnets, the adjusting of the control spring and jeweled bearing, are features to which special attention has been given by our best instrument makers.

SCALE. Each instrument is made with two scales so as to cover as wide a range as will be needed in any kind of work. Each scale is individual, calibrated, and hand drawn, the higher range drawn in black, and the lower range in red with binding posts carefully differentiated to avoid burning out by careless connections. The zero of each scale is at the left, giving wide scale divisions.

93–525 D'ARSONVAL LABORATORY AMMETER, jewel bearings, aluminum case, hand calibrated.
Range 0–25 amperes, scale drawn in black; 0–5 amperes, scale drawn in red **$9.40**

93–535 D'ARSONVAL LABORATORY VOLTMETER, jewel bearing, aluminum case, hand calibrated.
Range 0–120 volts in 2-volt divisions in black, 0–12 volts in 1/5 volt divisions in red **9.40**

WESTON AMMETERS AND VOLTMETERS, LABORATORY TYPE

93–550 DOUBLE RANGE AMMETER, 0–25 amperes
0–5 amperes **$16.25**

93–560 DOUBLE RANGE VOLTMETER, 0–150 volts
0–15 volts **16.25**

THE REMOVABLE SHUNT TRIPLE RANGE VOLT-AMMETER

No. 93–600

Patent Pending

Our Universal **Voltmeter** and **Ammeter** has been designed to give, in practical working form, all the ranges required in such work as is usually taken in technical school and vocational school laboratories, one instrument serving the purpose of six of the usual form commercial type. By this means it is possible to supply a complete working equipment for an entire laboratory division covering the ranges required for all practical measurements at an expense well within the reach of the average school desiring to give instruction in practical electrical measurements.

This instrument is of a distinctly high grade and designed for practical work, every possible provision having been made against liability of injury. Should, in the course of rough handling, the pointer be moved slightly from zero, ample provision has been made for ready re-setting, insuring the same degree of accuracy as the instrument originally had.

The ranges covered are as follows: —

Voltmeter, 0–150 volts,
0–15 volts,
0–3 volts,
Ammeter, 0–30 amperes,
0–15 amperes,
0–3 amperes.

Voltmeter. The resistances giving the various ranges are permanently attached, each brought out to its appropriate binding post, and cannot, therefore, be disconnected.

Ammeter. The various ranges of ampere needs are met by the use of our new form interchangeable shunt, the same as used in our Universal Galvanometer No. **93–130.**

Additional shunts may be supplied, if desired, giving other ranges than those specified. Shunts which are not in use are carried on the inside of the base, as noted in the illustration.

Mounting. Both the cap and base are of aluminum. The base is made separable to provide carrying space for the shunts not in use.

Binding Posts. Each binding post is clearly marked, giving use and range for which it is designed, thus avoiding possibilities of error resulting from wrong connections.

Scales. Various scales are carefully differentiated so that no error may be introduced into the work by carelessness in reading. It will be seen that we have covered in a most satisfactory way the six most important ranges of laboratory instruments and provided against every possible contingency in practical use.

93–600 THE REMOVABLE SHUNT TRIPLE RANGE VOLT-AMMETER $20.00

WESTON TRIPLE RANGE AMMETERS AND VOLTMETERS, LABORATORY TYPE

93–625 TRIPLE RANGE VOLT-AMMETER, laboratory type, covering three ranges of Voltmeters, three ranges of Ammeters, as follows: —

Volts, 0–150
0–15
0–3
Amperes, 0–30
0–3
0–1½ **29.75**

No. 93–635

THE MULTIPLE RANGE ROTARY METER

FOR

DIRECT CURRENT

Range, 0-30 and 0-3 Amperes, 0-100 Mill Volts (1-10 Volts)
0-1-10, 0-3 and 0-30 Volts

No. 93–635

The Multiple Range Rotary Meter is a portable universal measuring instrument 4½ inches × 3 inches × 2 inches high, a most convenient size for either instructor's or students' use.

The instrument is provided with six binding posts, clearly differentiated, yet so designed that even after connections are made to the appropriate posts, no current passes until the body of the instrument is turned in its socket so that the pointer rests on the desired range designated on the graduated surface which surrounds the body of the instrument, thus providing a double protection against accidental injury.

The base of the instrument contains a commutator which is stationary, mounted in a suitable receptacle having provision for a number of shunts and resistances, connections with which are made through the several segments of the commutator.

A Milvoltmeter is centrally pivoted to the commutator in such a way that the meter terminal makes connection with successive segments of the commutator as the meter is rotated on its axis. A fixed index finger on the side of the knurled meter case shows the position of this terminal and suitable markers on the surface of the commutator receptacle show the position of the segments.

No current passes through the meter unless the index finger points to the marker corresponding with the binding post connected with the source of current, thus greatly lessening the danger of damaging the instrument by overloading it through a wrong connection.

This invention practically reduces the problem of making a voltammeter with a number of scales to the simplicity of a low range single scale voltmeter, and should repairs be necessary, the probability of having to alter the adjustment of the extra shunts or resistances is very remote, a statement that cannot be made concerning the conventional type of voltammeter.

In the conventional type of voltammeter where the same moving system is utilized for current and voltage measurements, it is necessary to have two distinct windings on the moving coil and separate means of conducting the current to these windings, or else provide a switch in the moving system circuit to break the ammeter circuit when it is desired to measure voltage, either of which methods introduces complications which are both expensive and unreliable.

In the Rotary Meter there is but one winding in the moving system and one pair of conductors from the moving system to the contact terminals and these consist of two coil springs which serve the double purpose of carrying the current to the coil and furnish the controlling force of the movable member. All other coils and shunts are contained in the commutator receptacle each with its own circuit from the binding post to the corresponding segment of the commutator. This appears to be the last word in safety, simplicity and accuracy.

Instead of a multitude of coils and shunts crowded together in one case and an array of binding posts all connected permanently to the moving system inviting wrong connections, or a collection of coils and shunts, each separate and by itself, an inconvenience that few are willing to tolerate, the Rotary Meter combines in a convenient form the necessary coils and shunts each one in its own compartment and connected with a commutator which makes connection at will with the simplest form of indicating instrument that has yet been devised, and the whole occupying a space only 4½ x 3 x 2 inches.

Price **$16.00**

VOLT-AMMETERS

MAGNETIC VANE TYPE

Volt-ammeters. The line of Volt-ammeters which we list herewith is of the well-known **magnetic vane** type with **zero center** which avoids injury in case of wrong connections. This is a type of instrument which will commend itself to Physics teachers because of the readiness with which the student may obtain results reading directly in the fundamental units of Volts and Amperes, thus learning at the very beginning of his work the significance of the common commercial terms.

Double scale, jewel bearing, aluminum case with hand calibration, combine to give this instrument a value in laboratory work not equaled by any other medium-priced instrument on the market.

Ranges. The ranges selected are such as will be of the widest service in laboratory work.

93–650 **VOLT-AMMETER,** magnetic vane type, jewel bearing, aluminum mounting, range 10 volts and 10 amperes **$6.50**

93–670 **VOLT-AMMETER,** magnetic vane type, range 120 volts and 15 amperes **8.50**

NEW LINE OF ALTERNATING CURRENT AMMETERS AND VOLTMETERS

It is doubtless due to the great advance which has been made during the past few years in the production of iron with definite electrical qualities, that the alternating current measuring instrument has now reached its present high state of perfection. It is with pleasure that we call the line we here offer to the attention of laboratory workers.

Voltmeter. A thoroughly reliable Voltmeter giving a full scale deflection on 15 volts, a voltmeter of higher resistance than is commonly used in commercial instruments.

Ammeter. Our alternating current Ammeters will measure with commercial accuracy the output of magnetos and even the smallest size alternating current generators. The Ammeters in this class are of much lower resistance than the conventional type of alternating current instruments.

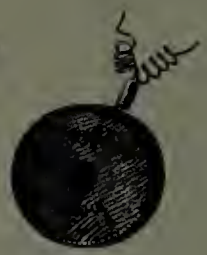
Mounting. These instruments are mounted in a 7-inch finely finished iron case with nickel trimmings and in the usual switchboard form. See the illustration above.

93–700 **VOLTMETER,** 7-inch case, 0-15 volts **$14.00**
93–710 ——, 0-125 volts **14.25**
93–720 ——, 0-500 volts **19.00**
93–740 **AMMETER,** 7-inch case, 0-1 ampere **13.00**
93–750 ——, 0-5 amperes **13.50**
93–760 ——, 0-25 amperes **13.50**
93–770 ——, 0-100 amperes **13.75**

ELECTRICAL RESISTANCE APPARATUS

RESISTANCE COILS

No. 94–20



No. 94–21

No. 94–30

No. 94–60

94–20 **ONE-OHM RESISTANCE,** after Millikan and Gale's "A Laboratory Course in Physics" (Experiment **33**) **$0.28**

94–21 **THOUSAND-OHM RESISTANCE COIL,** after Millikan and Gale's "A Laboratory Course in Physics" (Experiments **31** and **32**) . . . . . **.45**

94–30 **SPOOL RESISTANCES.** These spools are practically the same as those which are used in our high-grade resistance boxes. They are guaranteed to be accurate to ⅛ of one per cent.

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	
Resistance	1	2	3	4	10	20	30	40	50	100	200	300	400	1000	2000	3000	4000	Ohms
Each .	**$0.50**	**.55**	**.55**	**.55**	**.60**	**.62**	**.65**	**.68**	**.75**	**.80**	**.85**	**.95**	**1.00**	**1.50**	**1.75**	**2.00**	**2.20**	

94–60 **TEMPERATURE COIL** for use with Wheatstone Bridge in the study of effect of temperature changes on the resistance of a coil of wire.
This instrument consists of a spool of insulating material on which is mounted a coil of high resistance, the ends of which are terminated in heavy leads.
Complete as illustrated **$1.20**

94–61 **TEMPERATURE COIL,** after Turner and Hersey (Experiment **E081**) . . . . . **.15**

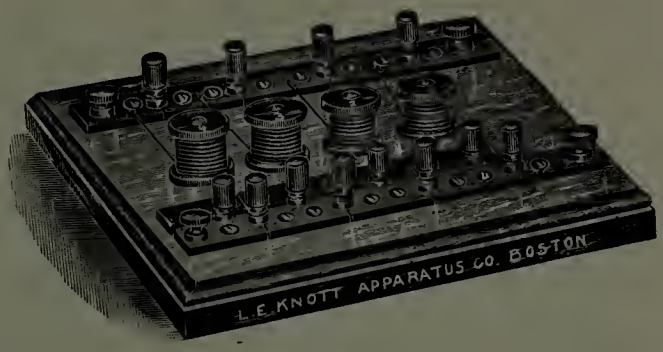
No. 94–70

94–70 **RESISTANCE COILS, HYDE FORM,** for use with Wheatstone Bridges, in determining the resistances of coils; also for formulating laws of resistance in wires. In our new design we have entirely obviated the danger of the ends of the coil becoming detached from the leads, — a very great advantage over the old forms.
As illustrated, this instrument consists of eight spools, of different lengths and different diameters and two different materials. Each spool is mounted on a pin fixed in a neatly finished baseboard.
To simplify the deriving of the laws of resistance we furnish eight spools capable of securing the following combinations: —

2 Spools, same material, same diameter, same length.
2 Spools, same material, same length, different diameters.
2 Spools, same material, same diameter, but one double the length of the other.
2 other Spools which, with combination with those above cited, will allow of comparison, of same diameter and same material, but of lengths as 1: 2: 3: 4: 5.
1 other Spool of same diameter but different material from one of the above named, but exactly ten times the length.

Set of eight spools complete, mounted on base as illustrated **$3.00**

No. 94–80



No. 94–90

94–80 RESISTANCE SPOOLS. Set of five spools of unknown resistance, all mounted on same spindle on a polished wood base, each with binding posts for connections to each or to all in the series.
This combination consists of the following spools: Copper Wire — 10 meters, Nos. **22** and **28**, and 20 meters, Nos. **22** and **28**; German Silver — 10 meters, No. **22** . . . . . Per Set **$2.90**

94–90 RESISTANCE BOARD, after C. H. Andrews of the South High School, Worcester, Mass.
This instrument consists of four bobbins, the wire so wound and connected as to make possible combinations as follows: 2 coils of same length and material, but of different diameter; 2 coils of same length and diameter but of different material, and 2 coils, same diameter and material, but of different lengths.
In the design of this instrument Mr. Andrews has taken pains to select wires the diameters and resistances of which have convenient ratios to each other and, therefore, best suited for use in parallel. The coils have the further advantage that they are so connected to the brass blocks that combinations in series or parallel of any one or more of the coils may be secured by proper placing of the plugs in their tapered holes.
This instrument is very carefully constructed; the plugs are nicely tapered and ground to fit the holes. Mounted as illustrated on a finished hardwood base **3.90**

94–95 CULLER'S DOUBLE RHEOCHORD. This outfit consists of a pair of Rheochord Boards, finished, provided with wire and binding posts; character, size, length and method of winding the wires as indicated in Culler's "Laboratory Manual of Physics" (Experiment **XLVc**) . . . . . Pair **6.75**

94–97 FULLER AND BROWNLEE RHEOCHORD BOARD, as specified in Fuller and Brownlee's "Laboratory Exercises" (Experiment **73**) **4.65**

94–98 RHEOCHORD BOARD, as specified in Millikan, Gale and Bishop's "Laboratory Physics" (Experiments **32** and **35**) **4.65**

Nos. 94–100 to 94–105

94–100 STANDARD RESISTANCES. The coil illustrated has been designed for use whenever the highest accuracy is not required, and the inconvenience attending the use of an oil bath can therefore be avoided. Though not intended as the highest standards, the accuracy and compactness make these coils convenient for many purposes. The winding is a matter of great care; the wire used is manganin, and the core on which the coil is wound is of brass. This core is open at each end, giving ventilation as well as preventing changing of temperature; also permitting the introduction of a thermometer into the interior. The winding is arranged in a thin layer on the core and insulated with only sufficient wax to prevent access of the air to the wire.
The case is of brass; the terminals are heavy copper rods giving ample conductivity and contact surface. The lower ends of these rods are arranged to dip into mercury cups, while the upper ends are equipped with large binding posts screwing into the copper bars and bearing against lugs which give ample clamping surface.
These coils are furnished in four different sizes as listed below. They are accurately adjusted to $\frac{1}{10}$ of one per cent. With each coil a certificate of accuracy giving the date, temperature, and precise value of the resistance at the final test is included.

	a	b	c	d
Capacity	1	10	100	1000 Ohms
Each	**$10.00**	**10.50**	**12.50**	**15.50**

94–105 STANDARD RESISTANCES, same as above, but adjusted to an accuracy of $\frac{1}{10}$ of one per cent. With these coils the certificate is not furnished.

	a	b	c	d
Capacity	1	10	100	1000 ohms
Each	**$7.50**	**8.00**	**9.50**	**12.50**

STANDARD RESISTANCES

Nos. 94–115 to 94–117

94–115 **STANDARD RESISTANCES,** Reichsanstalt Form, universally accepted for work of high precision. These have been evolved as an embodiment of the long experience of the German Government Bureau. The resistance material of these standards is manganin, selected not only for its approved permanence and low temperature resistance coefficient, but also for its small thermo-electro-motive force against copper. The external case is not in connection with the winding and furnishes merely a mechanical support and protection. The standard may be immersed in oil so that the coil is completely submerged, and the case, bobbin, and winding are so arranged that the oil has access to all parts of the coil, making it possible to ascertain or control its temperature with certainty. An opening through the ebonite top permits the insertion of a thermometer into the interior. Case and terminals are nickel-plated to prevent corrosion. Every operation of the construction of these standards, winding, aging, and adjustment, is most carefully carried out. Our standards will therefore be found not merely accurate in adjustment but also permanent in calibration. Each coil is adjusted to 1/100 of one per cent. of the value of our copies of the United States Standard. With each resistance sent out is a certificate of accuracy for each coil.

	a	b	c	d	e
Capacity	1/10	1	10	100	1000 ohms
Each	$45.00	45.00	45.00	45.00	45.00

94–117 **STANDARD RESISTANCES,** Reichsanstalt Form, same accuracy and general structure as above, but arranged for air cooling only.

	a	b	c	d
Capacity	1	10	100	1000 ohms
Each	$20.00	20.00	20.00	22.50

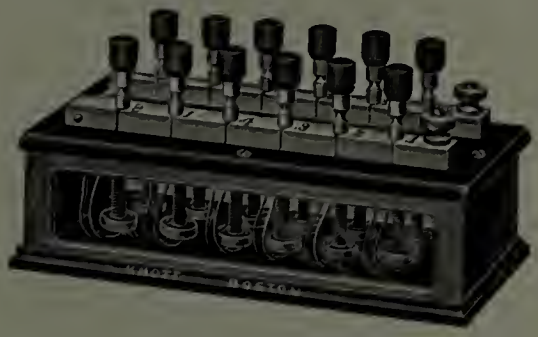
94–125 **SINGLE-COIL TENTH MEGOHM.** In the construction of this box we use one of the units of our Standard Megohm Box No. **94–225,** mounted in a cylindrical brass case with raised terminals, thermometer hole, and offered in form as illustrated.

Tenth Megohm Coil as illustrated $35.00

No. 94–125

RESISTANCE BOXES

Nos. 94–152 to 94–155



No. 94–160

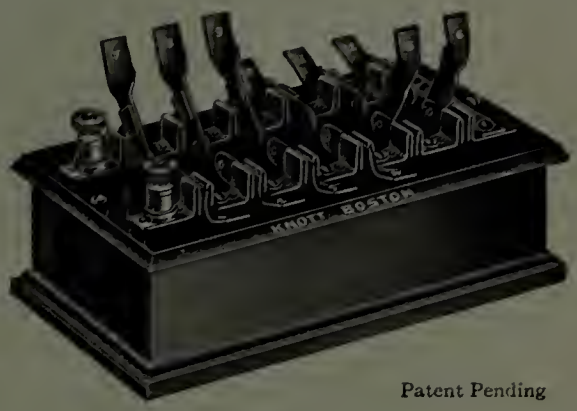
94–150 **SCHOOL RESISTANCE BOX,** range 1 to 20 ohms, guaranteed accuracy of ½ of one per cent. . **$3.75**

94–152 **SCHOOL RESISTANCE BOX,** range $\frac{1}{10}$ to 111 ohms, guaranteed accuracy of $\frac{1}{5}$ of one per cent. **7.50**

94–155 ——, same as above, but with certificate from our electrical laboratory **10.00**

94–160 **SCHOOL DEMONSTRATION RESISTANCE BOX.** This box is the same as above, but supplied with glass front and back that students may see the internal construction of a resistance box. By this method the coil connections may readily be observed, and the pupil is enabled to judge for himself the structure of an ordinary resistance box **9.50**

94–170 **B–P SWITCH RESISTANCE BOX.** The illustration above shows our resistance box fitted with the new **B–P Switch** in which we believe a great step has been taken in the proper direction, for this simple device comprises the good points of the plug and associates with them the valued features of a switch mechanism. In the design of the switch care has been taken to retain only the good features and it will be found both rapid and dependable in accurate work.



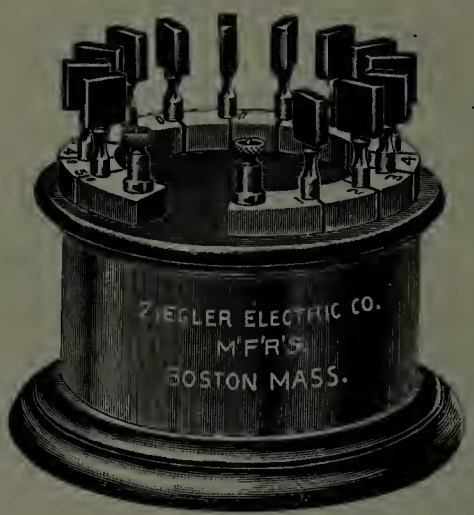
Patent Pending

No. 94–170

POINTS OF MERIT

1. One throw of the hand puts a coil in or out of circuit as desired.
2. The closing of the switch is always accompanied with a wedging rubbing action similar to that met with in perfectly fitted plugs.
3. The resistance of the closed switches is extremely low.
4. It is not necessary to open the switches when not in use, as the expansion of the rubber upon which they are mounted can do no harm.
5. There are no loose parts to become lost or mixed.
6. The values of the coils in or out of circuit can be told at a glance.
7. The values of the coils are marked upon the switch blade handles, which are always up in plain sight when open, so that it is not necessary to get directly over the box to obtain their values.
8. Portions of the switch device extend through the top of the resistance box and are directly soldered to the coil terminals, thereby insuring against unreliable screw contact joints, etc.
9. The simplicity of construction enables drawn metal of unusually low and uniform resistance to be used to advantage.
10. There is no chance for dirt and filings to lodge and short-circuit the coils.
11. It is very rapid.
12. Perfection of contact does not depend upon accurately reamed contact surfaces that may be badly injured by use or abuse.

The coils contained in this box are made and tested by our standard process, and their accuracy is fully equal to that of any box on the market. The coils are each guaranteed accurate to ½ of one per cent. The total resistance is 111 ohms divided as follows: — 0.1, 0.2, 0.3, 0.4, 1, 2, 3, 4, 10, 20, 30, 40 ohms **$5.90**



No. 94–180

94–180 SUPERIOR ROUND FORM PLUG RESISTANCE BOX. This box is an excellently finished, reasonably priced high-grade instrument. Contains 13 coils ranging from 1/10 to 50 ohms, with total resistance of 161 ohms. Each instrument is guaranteed accurate to within 1/5 to 1/10 of one per cent. **$7.80**

No. 94–190

94–190 TRAVELING PLUG RESISTANCE BOX. This box is provided with extra heavy brass blocks and reinforced ebonite top. Contains 12 coils ranging from 1 to 400 ohms, with total resistance of 1110 ohms. The usefulness of the instrument is increased by the addition of two traveling plugs facilitating its use in the comparison of electro-motive force of batteries, and other tests. Guaranteed accuracy of 1/5 to 1/10 of one per cent. **$25.00**

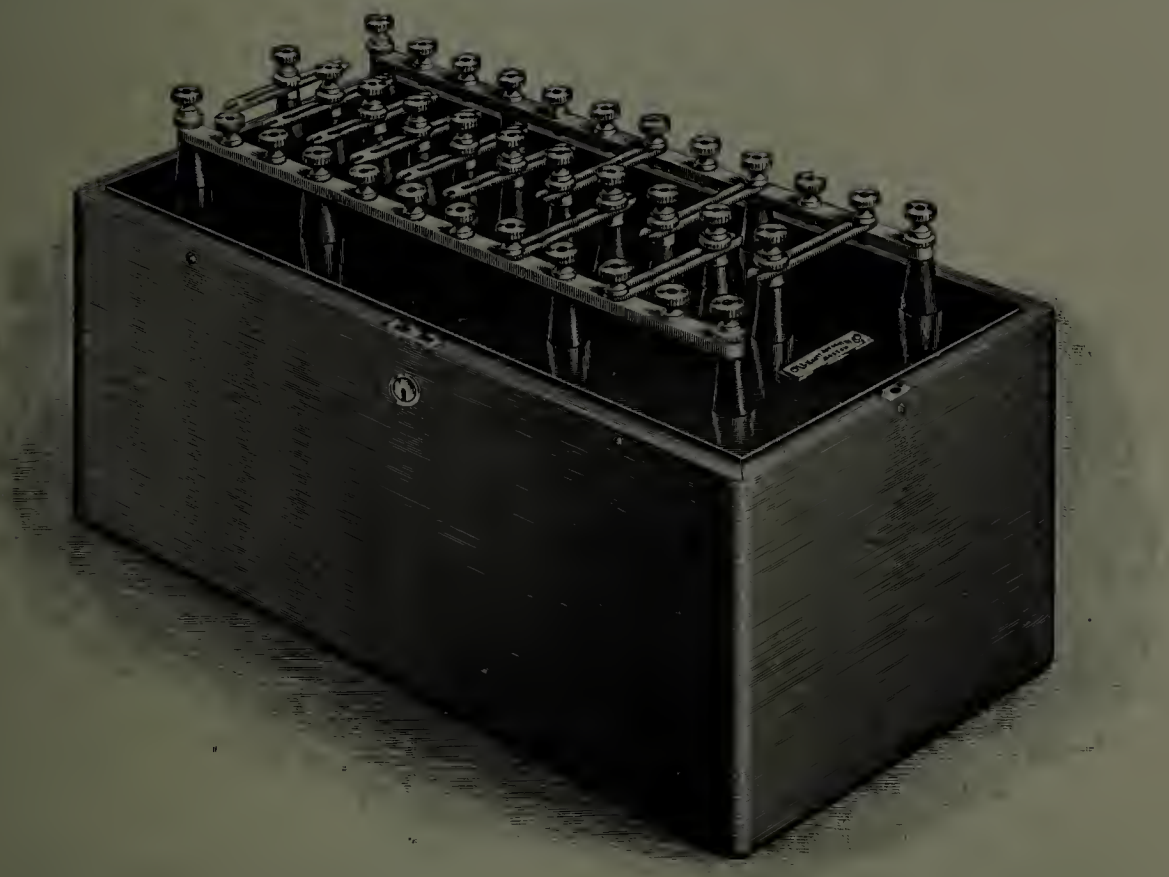
94–195 TRAVELING PLUG RESISTANCE BOX, similar to above but constructed for greater range. Contains 16 coils ranging from 1 to 4000 ohms with total resistance of 11,110 ohms. Guaranteed accuracy of 1/5 to 1/10 of one per cent. **30.00**

No. 94–200d

94–200 DECADE RESISTANCE BOX, with sliding contact and connections; best material, highest accuracy, improved positive contact secured by the laminated contact brushes.

	a	b	c	d
No. of Decades . . .	3	4	5	6
Each	**$90.00**	**118.00**	**140.00**	**165.00**

MEGOHM BOX



No. 94–225

94–225 **STANDARD MEGOHM BOX, range 10,000 to 1,000,000 ohms,** an arrangement for a megohm resistance which gives the greatest attainable flexibility and convenience without diminishing the accuracy.

General Arrangement. Highly insulated binding leads, easily accessible buss bars for changing of the connections. A total resistance of one megohm is obtained by putting 10 coils, each of 100,000 ohms, in series. Joining in multiple, a minimum resistance of 10,000 ohms is obtained. Any range between the two in steps of 10,000 ohms is readily obtained. The importance of this arrangement in accurate comparisons of high resistances cannot be overestimated.

Insulation. Perfect insulation is a requisite in all high resistance work. As will be noted, the box is made of large proportions, raised ebonite insulated terminals, so designed as to be easily cleaned. This feature should not be overlooked in practical work. The box is also provided with a cover, not shown in the illustration. This feature we consider essential in order that the insulating qualities of the ebonite may be retained.

Connections. Note the new sliding link running from buss bars to binding posts. This adds greatly to the convenience of connecting, insures against any of the connectors being lost and makes it possible to attain quickly the necessary changes in the least possible room.

Coils. The coils are wound non-inductively with our special "B" high resistance wire, which we consider for purposes of a megohm box superior to manganin as used in all of our low range boxes. Each coil is thoroughly protected from moisture by wax and insulating covering, which also seems to give to each unit ability to withstand mechanical strains.

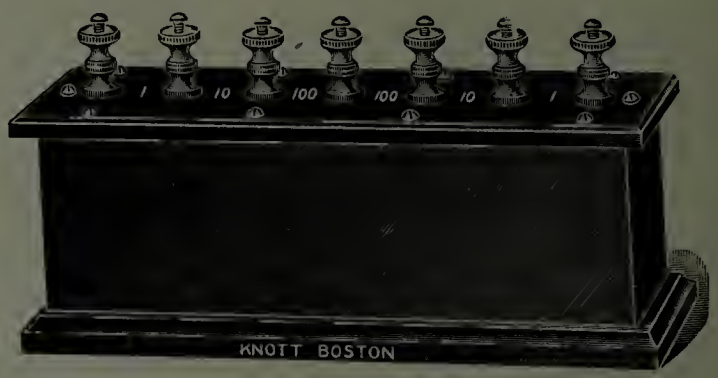
Standard Megohm Box **$140.00**

94–230 **STANDARD TENTH MEGOHM BOX.** We have had frequent calls for a box similar to our No. **94–225,** but utilizing the Wolff method of connecting and other features in its construction, but of lower range. We therefore offer the same box with the same number of coils but of lower unit denomination, making the total resistance of the box $\frac{1}{10}$ megohm. Each coil has a resistance of 10,000 ohms; 100,000 ohms may be secured by connection in series, 1,000 ohms by connection if in multiple.

Standard Tenth Megohm Box **100.00**

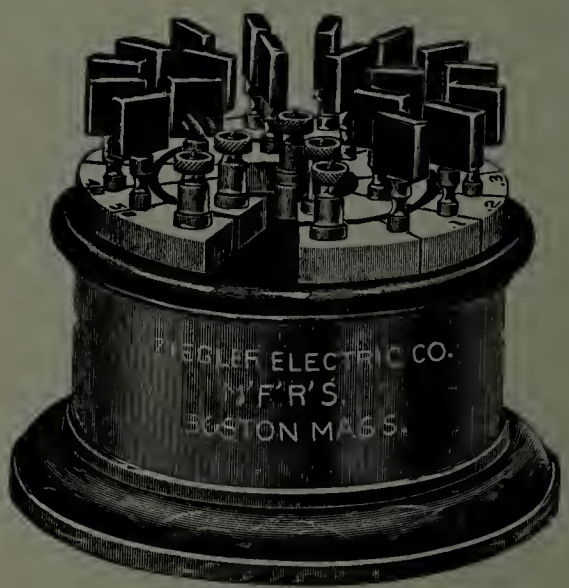
Standard Tenth Megohm Coil. See No. **94–125.**

COMBINED BRIDGE AND RESISTANCE BOXES



No. 94-250

94-250 RATIO BOX. In Wheatstone Bridge work it is essential that easily accessible ratio arms be provided. This box has been designed for this particular purpose. It contains six coils as follows: — 1, 10, 100, 100, 10, and 1 ohms, which will give nine different working ratios. Each coil is guaranteed accurate to 1/10 of one per cent. It may therefore be seen that with this accuracy the ratio box may be used as a standard resistance of 222 ohms capacity **$10.60**

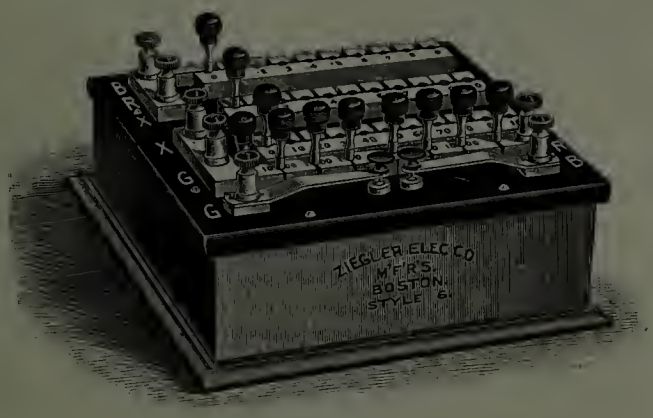


No. 94-260

No. 94-270

94-260 ROUND TYPE PLUG BRIDGE AND RESISTANCE BOX. Contains 13 coils ranging from 1/10 ohm to 50 ohms, giving a total resistance of 161 ohms, in addition to the bridge coils which have the following resistance of: 100, 10, 1, 1, 10, and 100 ohms. It may therefore be seen that the total range is from .001 ohm to 17,600 ohms. This instrument is recommended as one of great accuracy, giving a wide range. Guaranteed accuracy of 1/5 to 1/10 of one per cent. **$18.50**

94-270 IMPROVED COMBINED BRIDGE AND RESISTANCE BOX. Bridge coils are 1, 10, 100, 100, 10, and 1 ohms. Resistances range from 1 to 400 ohms. Total resistance 1110 ohms. Total range of measurements from .01 ohm to 111,000 ohms. Guaranteed accuracy 1/5 to 1/10 of one per cent. . . **25.00**



No. 94–280

94–280 ZIEGLER BRIDGE AND RESIDTANCE BOX. This box has been especially designed to meet the constant demands for a reliable and conveniently arranged combined box giving a wide range, yet one which can be furnished at a price within the appropriation of most schools.

The first row of the resistance box contains nine 1/10-ohm coils; the second 10 1-ohm coils; the third ten 10-ohm coils. The total range of measurement, therefore, is from .001 ohm to 11,090 ohms. Separate keys properly connected for battery and galvanometer are mounted as illustrated. Coil accuracy guaranteed to 1/10 of one per cent. **$34.75**

No. 94–285

94–285 ZIEGLER IMPROVED COMBINED BRIDGE AND RESISTANCE BOX. This box is in general similar to No. **94–280.** It has, however, a larger capacity and the blocks are extra heavy. The bridge coils are 1000, 100, 10, 1 ,100, 1000 ohms. The resistance box coils range from 1/10 ohm up to 4,000 ohms. Total resistance 11,111 ohms. Range .0001 ohm to 11,110,000 ohms. Coil accuracy guaranteed to 1/10 of one per cent. **$50.00**

PRECISION RESISTANCE BOX AND BRIDGE

No. 94–300

94–300 STANDARD PRECISION RESISTANCE BOX, designed to give the highest degree of precision of which the plug contact form of Wheatstone Bridge is capable; constructed to furnish the best that modern research has produced.

Range. The one-ohm Ratio Coil can be thrown into either arm desired by means of one of the traveling plugs supplied with the box. The range of the bridge is, therefore, from .001 to 11,110,000 ohms.

Resistance Arms —				
	1	10	100	1000 ohms
	2	20	200	2000 "
	3	30	300	3000 "
	4	40	400	4000 "
Bridge Arms —				
	1	10	100	1000 ohms
		10	100	1000 "
	Total			13,331 ohms

Accuracy. All the features tending to give permanency of calibration as well as accuracy have been studied in every detail. The coils in the ratio arms are adjusted to 1/10 of one per cent.; those in the ratio arms to 1/20 of one per cent. With a proper handling of this box, results may be secured limited only by the inherent capabilities of the plug contact form.

For details of construction, see special circular which will be mailed upon request.

SPECIAL FEATURES

Coils of manganin wire, aged by our special process, wound on hollow brass bobbins, securing perfect insulation and greater carrying capacity, individually tested, and attached by special arms, permitting new coils to be furnished and attached by user.

The **Insulation** is of the very highest quality, interior of box practically moisture proof to insure permanency of insulation.

Connecting Blocks of unusually large size, of ample clearance and special provision for cleaning.

Traveling Plugs, — two furnished with each box.

Coil Plugs, rubber handles, diamond form; tapers designed for constant use without contact error.

Grid Support, on interior of box to prevent springing of top by excess plug pressure.

Cover. Dust-tight, provided with each box to insure life of rubber top.

Standard Precision Resistance Box, as above described **$110.00**

Patents Pending

UNIVERSAL LECTURE TABLE RHEOSTAT AND RESISTANCE FRAME

A Group Cut Illustrating the Following Numbers

In designing the above apparatus we had two primary objects in mind; first, to make available an easily understood, readily controllable rheostat, which could not get out of order, designed for use on 110 volt current; second, a satisfactory method of teaching the effect of different methods of lamp connections in the electrical circuit.

Should the instructor not care to have the light which comes from the lamps when used as resistances, dark units as illustrated are now available, giving currents of from 0.6 to 5 amperes each, so that combining these in multiple and in series, a wide range of current may be obtained graded in small steps, as the instrument itself will carry from 50 to 75 amperes with perfect safety.

In outfit No. **94–350** lamps only are furnished and the outfit may well be called a Universal Lamp Resistance Board, giving ampere strengths from 0.2 to 6.00 amperes.

A wide range of ampere values may be secured by using the resistance units in series, multiple or series-multiple arrangement. Outfits Nos. **94–353** to **94–358** are supplied with resistance units only. These outfits are recommended for all laboratory resistance work.

The fuse plugs have negligible resistances and are used for facilitating connections.

The value of the apparatus as a practical rheostat of wide ampere ranges is greatly enhanced by its value as an instrument to simplify and demonstrate Ohm's Law, Three Wire System of Connection, Voltage Drop, Efficiency of Various Types of Lamps and other allied subjects.

94–350	**UNIVERSAL RESISTANCE FRAME,** complete with Sockets and Lamps giving ampere strengths from 0.2 to 6 amperes	**$11.00**
94–353	——, complete with Resistance Units giving ampere strengths from 0.2 to 7.2 amperes by 0.6 ampere steps	**18.50**
94–356	——, complete with Resistance Units giving ampere strengths from 0.2 to 18 amperes by 0.6 ampere steps	**26.50**
94–358	——, complete with Resistance Units giving ampere strengths from 0.2 to 40.5 amperes by 0.6 ampere steps	**42.25**
94–360	**MOUNTED D. P. D. T. KNIFE SWITCH,** — capacity 50 amperes at 250 volts. Slate base mounted on heavy slate sub-base	**2.75**
94–365	**RIGID ARM PORCELAIN MOUNTED SOCKET** for holding lamps, bridge and fuse plugs. Each	**.75**
	Six	**4.00**
94–375	**HARCOURT RESISTANCE UNIT,** — 6 inches long, 0.6 ampere capacity	**1.50**
94–376	——, 8 inches long, 1.2 amperes capacity	**2.00**
94–377	——, 10 inches long, 2.5 amperes capacity	**2.75**
94–378	——, 12 inches long, 5 amperes capacity	**3.25**
94–380	**FUSE PLUG, EDISON BASE,** carrying capacity 3 amperes	**.10**
94–385	**SPECIAL BRIDGE PLUG**	**.60**
	NOTE. — We should be pleased to send a special descriptive circular showing by diagrams many profitable experiments.	
94–390	**LAMP BOARD, with 32 C. P. LAMPS,** after Fuller and Brownlee (Experiment **77**)	**9.80**

RHEOSTATS

This type of Rheostat comprises a layer of high resistance wire wound on an insulating fire-proof slab mounted on a polished wooden base with asbestos shield. They are fitted with suitable slider and binding posts for connecting in the circuit. Their open construction commends them for general laboratory work.

In selecting a Rheostat make sure that the ampere capacity is ample to meet the requirements.

No. 94–405

No. 94–410

BATTERY RHEOSTATS. The following capacities of the simple type instrument illustrated under No. 94–405 will be found well suited to battery or other low voltage circuits, or for use in connection with apparatus that consumes a large proportion of the energy of the power circuit.

Number	Voltage	Maximum carrying Capacity Amperes	Resistance Ohms	Size Inches	Weight Ounces	Price, Duty Free
94–400 A	12	7	1.7	4¾ × 1 3/16 × 19/32	10	. . . .
94–400 B	15	10	1.5	6 5/16 × 1 9/16 × 19/32	14	. . . .
94–400 C	24	3	8	4¾ × 1 3/16 × 19/32	10	. . . .
94–400 D	25	10	2.5	8 × 2 × ¾	42	. . . .

SIMPLE RHEOSTATS, especially adapted to power circuits.

Number	Voltage	Maximum carrying Capacity Amperes	Resistance Ohms	Size Inches	Weight Ounces	Price, Duty Free
94–405 A	800	.3	2400	18 × 2⅜ × 1⅜	137	. . . .
94–405 B	112	.3	250	4⅜ × 1 3/16 × 19/32	10	. . . .
94–405 C	110	1	110	6 5/16 × 1 9/16 × 19/32	14	. . . .
94–405 D	110	5	22	16 × 2 × 1	118	. . . .

DOUBLE RHEOSTATS, similar to the previous type of instrument, but comprising two wire-carrying mounted slabs on a common base. This construction enables a much larger capacity to be attained in a given space.

Number	Voltage	Maximum carrying Capacity Amperes	Resistance Ohms	Size Inches	Weight Ounces	Price, Duty Free
94–410 A	100	10	10	12 × 2⅜ × 1⅜	150	. . . .
94–410 B	110	20	5.5	18 × 2⅜ × 1⅜	218	. . . .
94–410 C	140	7	20	12 × 2⅜ × 1⅜	150	. . . .
94–410 D	330	3	110	12 × 2⅜ × 1⅜	150	. . . .
94–410 E	700	1	700	12 × 2⅜ × 1⅜	150	. . . .

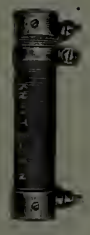
No. 94–415

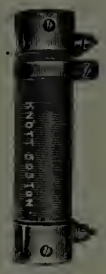
94–415 SIX-INCH REGULATING RHEOSTAT. Designed primarily as a fan motor speed regulator, this Rheostat has been modified for use as an adjustable resistance. Maximum watt capacity 125. Seven contacts, one "off" point and six running positions of 150 ohms per step. Maximum amperes 10.

Mounted on marbleized slate panel as illustrated **$3.50**

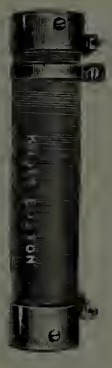
RESISTANCE UNITS

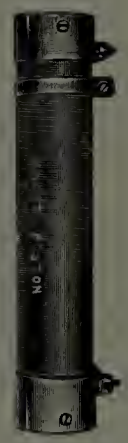
Resistance Units Grouped


No. 94–420



No. 94–425


No. 94–430


No. 94–435

RESISTANCE UNITS, approximate dimensions ¾ × 4 inches.

50 Watts Continuous Duty

Number	Maximum Amperes	Resistance Ohms	Duty Free, Price	Number	Maximum Amperes	Resistance Ohms	Duty Free, Price
94–420 a	0.45	250	. . . .	94–420 h	3.3	4.5	. . . .
—— b	0.6	125	. . . .	—— i	3.6	3.9	. . . .
—— c	0.8	75	. . . .	—— j	5	2	. . . .
—— d	1	45	. . . .	—— k	6.4	1.2	. . . .
—— e	1.25	32	. . . .	—— l	9	0.6	. . . .
—— f	1.7	16	. . . .	—— m	12	0.35	. . . .
—— g	2.3	9	. . . .	—— n	14	0.25	. . . .

RESISTANCE UNITS, approximate dimensions 1⅛ × 4¾ inches.

85 Watts Continuous Duty

Number	Maximum Amperes	Resistance Ohms	Duty Free, Price	Number	Maximum Amperes	Resistance Ohms	Duty Free, Price
94–425 a	0.45	420	. . . .	94–425 h	2.8	11	. . . .
—— b	0.6	220	. . . .	—— i	3.2	8	. . . .
—— c	0.8	140	. . . .	—— j	5	3.5	. . . .
—— d	1.0	85	. . . .	—— k	6.2	2.2	. . . .
—— e	1.2	60	. . . .	—— l	8.5	1.1	. . . .
—— f	1.6	32	. . . .	—— m	11.5	0.65	. . . .
—— g	2.2	18	. . . .	—— n	14.4	0.4	. . . .

RESISTANCE UNITS, approximate dimensions 1⁵⁄₁₆ × 6¼ inches.

150 Watts Continuous Duty

Number	Maximum Amperes	Resistance Ohms	Duty Free, Price	Number	Maximum Amperes	Resistance Ohms	Duty Free, Price
94–430 a	0.45	800	. . . .	94–430 h	2.8	20	. . . .
—— b	0.6	450	. . . .	—— i	3.2	13	. . . .
—— c	0.8	240	. . . .	—— j	5	6	. . . .
—— d	1	150	. . . .	—— k	6.5	3.5	. . . .
—— e	1.2	95	. . . .	—— l	8.5	2	. . . .
—— f	1.6	54	. . . .	—— m	12	1	. . . .
—— g	2.2	32	. . . .	—— n	14	0.8	. . . .

RESISTANCE UNITS, approximate dimensions 1½ × 7¹³⁄₁₆ inches.

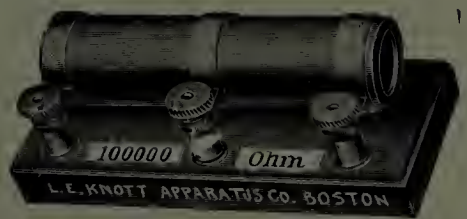
200 Watts Continuous Duty

Number	Maximum Amperes	Resistance Ohms	Duty Free, Price	Number	Maximum Amperes	Resistance Onms	Duty Free, Price
94–435 a	0.45	1100	. . . .	94–435 h	2.8	27	. . . .
—— b	0.6	560	. . . .	—— i	3.2	18	. . . .
—— c	0.8	320	. . . .	—— j	4.7	9	. . . .
—— d	1	200	. . . .	—— k	6.3	5	. . . .
—— e	1.2	140	. . . .	—— l	8.5	2.8	. . . .
—— f	1.6	72	. . . .	—— m	11.5	1.5	. . . .
—— g	2.1	45	. . . .	—— n	13	1.2	. . . .

Nos. 94–420 to 94–435 not furnished from stock. Imported Free of Duty only when ten or more are ordered.

94–440 GRAPHITE HIGH RESISTANCE. This resistance will be found of great convenience in experimental and testing work. Its low price and excellent appearance recommend it for many purposes. Resistance is mounted on polished wood base provided with binding posts for connections. Capacity 1,000,000 ohms; size of cylinder 4⅜ × 1¾ inches $9.75

94–442 ——, same as above, but 100,000 ohms 7.25

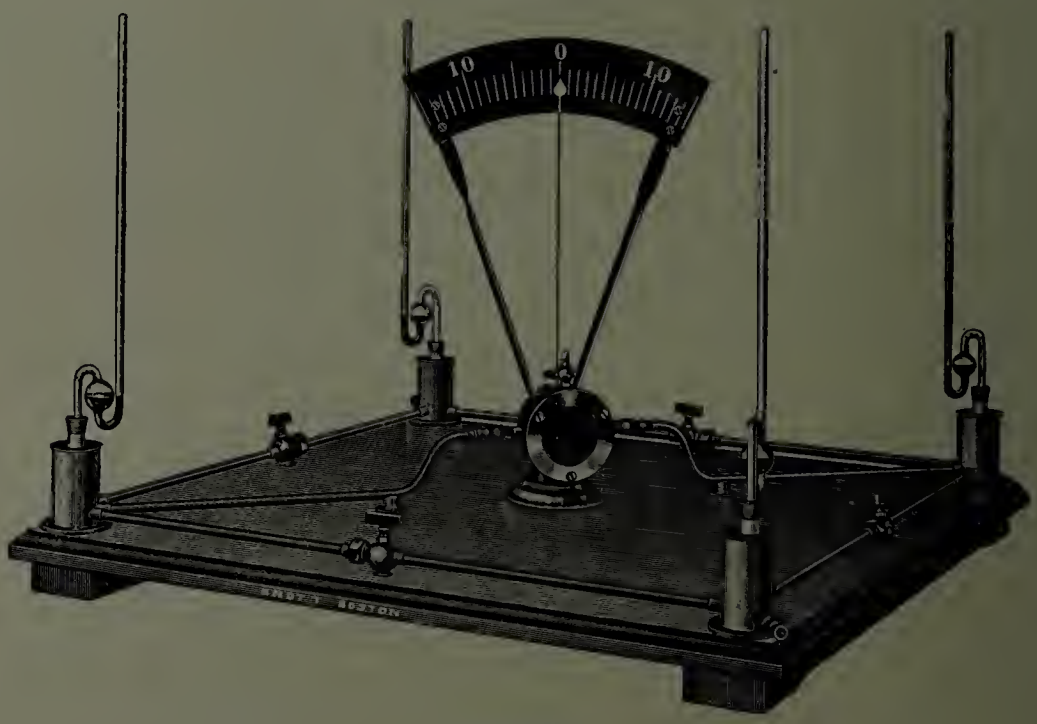


No. 94–442

WHEATSTONE BRIDGES

DEMONSTRATION WHEATSTONE BRIDGES

Too little attention has been given in schools to a thorough understanding of that basic principle, Fall of Potential, fundamental to Wheatstone Bridge work. A student's incomplete understanding of Fall of Potential makes it difficult for him to understand what he is striving to obtain when he uses a Wheatstone's Bridge. This incomplete understanding is due, perhaps, to the word of mouth descriptions and the lack of adequate illustrative demonstrative apparatus. To picture for him the actual Fall of Potential, we heartily recommend the following apparatus. The analogy between hydraulic pressure and electromotive force is often resorted to by teachers, yet the analogy has never been worked out instrumentally except in the following apparatus.



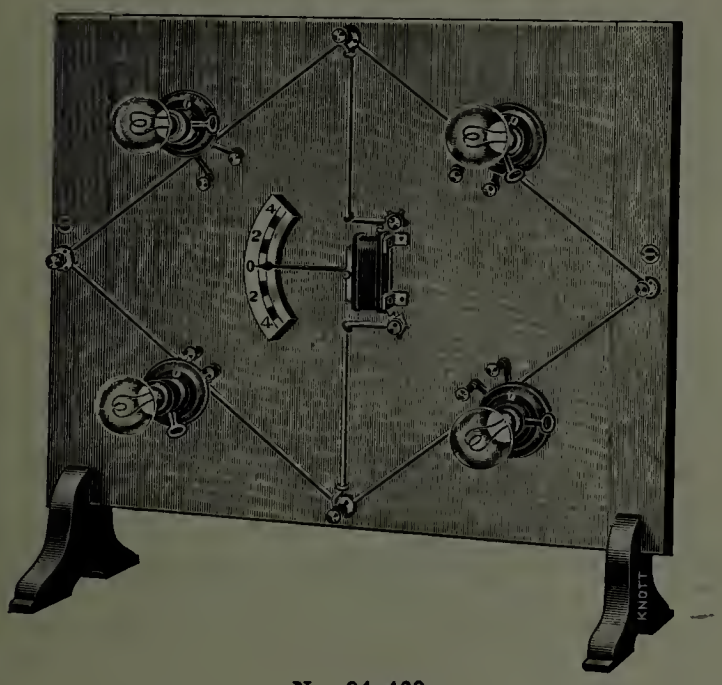
No. 94–455

94–455 **HYDRODYNAMIC WHEATSTONE BRIDGE** for a study of the principles involved by measurements of resistances by the Wheatstone's Bridge method, using Fall of Hydraulic Pressure as an analogy to electromotive force. On a polished wooden base board is mounted a system of tubes connected to form a Wheatstone's diagram. In the "arms" are reducing valves analogous to resistances. Pressures in the various arms are indicated by the manometers. In the "bridge" is a pressure indicator analogous to the galvanometer.

By connecting to one of the nipples noted in the illustration and allowing a flow of water through the apparatus, the fall of pressure through the different arms may readily be noted. By regulating the reducing valves in these arms, a balance may be secured when no indications of pressure can be noted in the "bridge." The pressures in the arms will then be noted in the manometer.

The didactic value of this apparatus will readily be noted. The construction is substantial, results possible are positive, parts are carefully fitted and handsomely finished.

Complete as illustrated $34.50



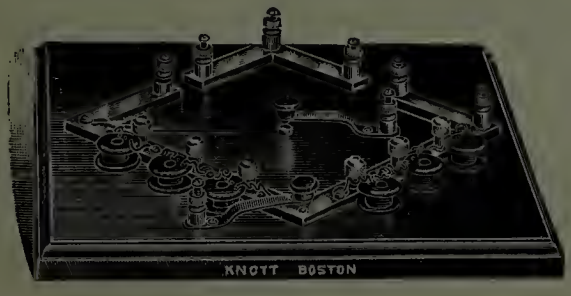
No. 94–460

94–460 DEMONSTRATION WHEATSTONE BRIDGE for a study of Fall of Potential and demonstration of the principle of a Wheatstone Bridge.

This apparatus consists of a vertically-mounted board to which is attached the Wheatstone Diagram. In the "arms" are connected incandescent lamps. In the "bridge" an indicating galvanometer. Binding posts are provided for connecting resistances in shunt with the lamp. By varying the resistances a point of same potential may be secured.

As a companion instrument to No. **94–455** Hydrodynamic Wheatstone Bridge, demonstrations of Fall of Potential as utilized in the Wheatstone Bridge are simply and clearly made.

Complete as illustrated with incandescent lamps **$26.00**

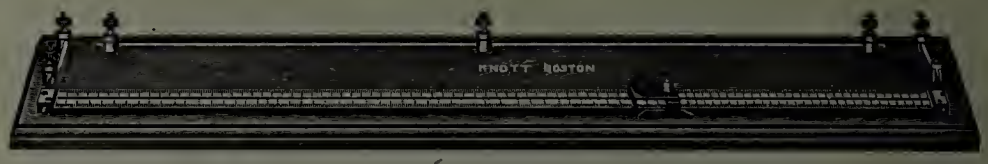


No. 94–470

94–470 WORKING DEMONSTRATION WHEATSTONE BRIDGE, DIAMOND FORM. The merit of a Wheatstone Bridge that may be used equally as well in demonstration as in laboratory practise will at once be recognized.

The instrument illustrated is constructed so that the arms are arranged as the Wheatstone Diagram. In addition in each of the "ratio arms" are coils of 1, 10, and 100 ohms. The "balance arms" are provided with gaps each with non-detachable binding posts, one pair for the known and the other pair for the unknown resistance. Non-detachable binding posts and key are provided for battery and galvanometer circuits. All parts of this instrument are well made. They are carefully fitted and the instrument is guaranteed to give good satisfaction **$5.80**

SLIDE WIRE WHEATSTONE BRIDGES



No. 94–480

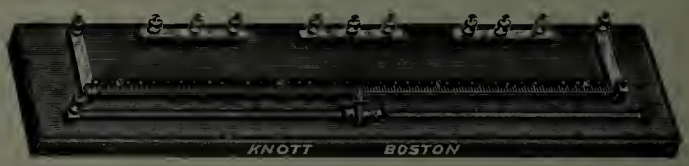
94–480 **WHEATSTONE'S STANDARD METER SLIDE WIRE BRIDGE.** In this design, especially adapted for students' laboratory experiments, we furnish an excellent bridge at a reasonable price. Heavy copper leads, non-detachable binding posts, manganin wire, improved positive sliding contact key, mounted on polished hardwood base **$3.35**

94–482 **WHEATSTONE'S BRIDGE,** after Millikan and Gale's "A Laboratory Course in Physics" (Experiments **32** and **33**) **2.00**

No. 94–490

94–490 **WHEATSTONE'S HALF METER BRIDGE, HARCOURT FORM.** This bridge is in construction similar to No. **94–480,** and in quality fully its equal.

To economize space as well as facilitate its use, it is made in half meter length, but so designed as to carry the full meter length of wire. In accuracy, therefore, it compares favorably with the full-length bridge **$2.80**



No. 94–495

94–495 **HALF METER WHEATSTONE-CAREY-FOSTER BRIDGE.** Extra heavy brass strips, non-detachable binding posts, improved sliding knife-edge contact key, improved scale mounted on highly polished base **$9.00**

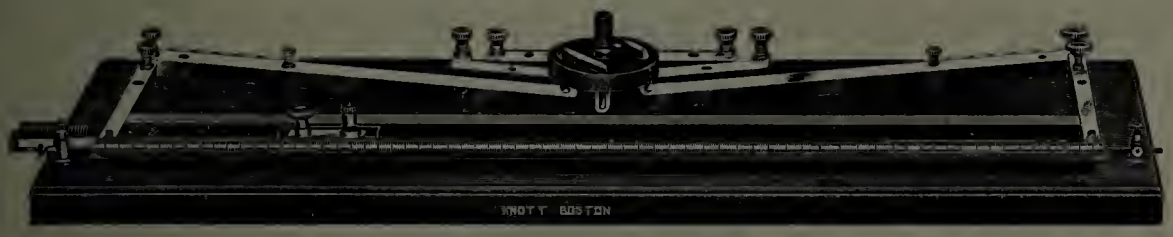
No. 94–500

94–500 **COWEN COMBINATION BRIDGE.** This Bridge was first constructed for the Boston High Schools, but is now generally recognized as a Wheatstone Bridge having unusually valuable educational features.

It is provided with an especially designed resistance box set in the base, and furnished as a part of the instrument. A horizontal D'Arsonval Galvanometer No. **93–195** is also mounted on the base. Thus it may be seen that a complete measuring unit combining bridge, resistance box, and galvanometer is furnished as a unit system. The necessity, therefore, of all outside connections except those from the battery and unknown resistance is entirely avoided. The permanent connections to the resistance box and the galvanometer are made on top of the bridge in such form that the direction of the current can be most easily traced.

Combination Bridge, Box, and Galvanometer **$22.50**

94–502 **COWEN COMBINATION BRIDGE** and Box without Galvanometer **15.00**



No. 94–525

94–525 **THE UNIVERSITY SLIDE WIRE BRIDGE,** adapted for measuring resistances with low E. M. F. where the plug form of Resistance Box would be useless. Provided with both mercury cup and binding post contact, the Lattimer-Clark Commutator, tension spiral for bridge wire, contact with rack and pinion and fine adjustment, locking device for holding the contact at any desired point.

Connecting bars of large cross section, tested for uniform density. Mercury cups of ½ inch diameter with bottom finished to give perfect contact.

Binding posts of large size, provided for each gap in addition to the mercury cup.

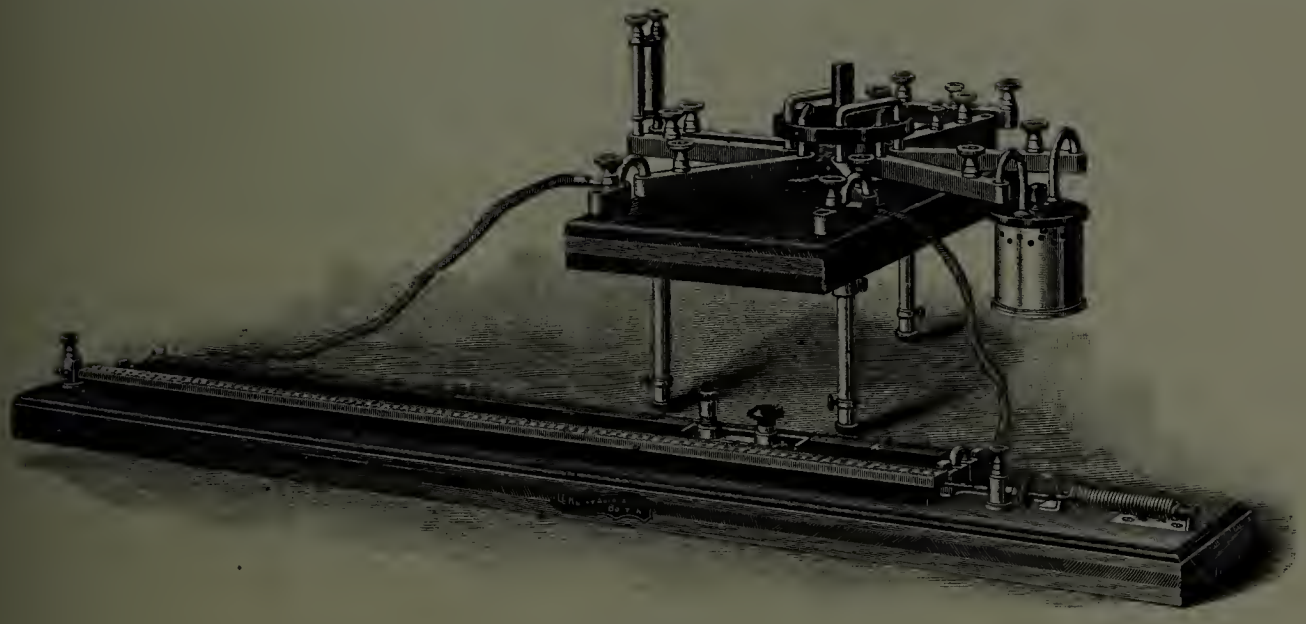
Four gaps are provided for ratio coils and extension coils, which are also available for inserting coils in the conventional Wheatstone Bridge arrangement. The commutator may be removed, leaving available two extra gaps which may be required in special work.

Spring Tension insures uniform tension on the resistance wire. Wire supplied for this work will be manganin unless otherwise specified.

Slider. Combination Rack and Pinion and fine adjustment with push button locking device, makes a most satisfactory method of obtaining a sliding contact. The contact is entirely enclosed to overcome any possible thermo-electric disturbance due to the presence of the hand of the operator. The scale is engine-divided with vernier reading to tenths of a millimeter.

Base is of three-ply mahogany to prevent warping, oil finished.

An instrument of the highest accuracy and convenience, substantially and beautifully finished . . $75.00



No. 94–535

94–535 **THE UNIVERSAL CAREY-FOSTER BRIDGE.** The Carey-Foster method is recognized as the one suited to the most rapid and accurate work in electrical measurements. It is, in fact, the method which we have found in our own testing department to give not only the most reliable results, but one which permits the largest number of measurements per unit of time.

The Bridge above illustrated is substantially the one used in our own electrical measurements, and is therefore adapted to a very wide range. The low resistance swinging arms, the mercury contacts, the sliding bridge, the essential features of which are made substantially as in instrument No. **94–525,** the micrometer movement on the contact, the heavy insulated low resistance copper leads, the Carey-Foster reversing key, combine to give this instrument a place in high-grade electrical measurements not filled by any other form.

The accuracy with which this Bridge is made will perhaps be appreciated when it is known that even the ½-inch copper lead wires and the heavy copper buss bars are carefully tested and adjusted before being set up in the instrument.

The **bases** are made of three-ply mahogany finished in oil; the finish on the entire instrument is in keeping with that of a thoroughly high-grade, accurate, scientific instrument $110.00

TRANSFORMING AND INTERRUPTIVE APPARATUS

No. 95–10

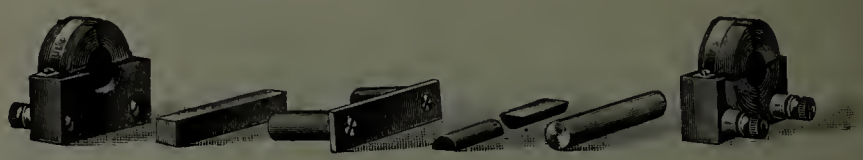
95–10 FARADAY'S RING AND DEMONSTRATION TRANSFORMER. This simple apparatus is designed for study of the principles and laws involved in self and secondary induction; also the applications of these laws to the step-up and step-down transformer.

It consists of a closed magnetic circuit within a coil of wire which is tapped and brought to binding posts, dividing itself into four coils of an equal number of turns. The ring and binding posts are mounted on a neatly finished, polished base, making a compact, well worked out instrument in which the ratios of transformation on a unit of voltage are as follows: —

1:1; 1:2; 1:3; 1:4; 2:1; 2:3; 3:2; 3:1; 4:1 . . . . . **$3.25**

95–15 INDUCTION COIL, after Millikan, Gale & Bishop, Exp. 36.

This is a simple coil of wire wound on a brass spool . . . . . Each **.55**



Figs. 1 2 3 4 5 6

Figs. 7 8 9

No. 92–130

92–110 GILLEY INDUCTION COILS, Figs. **1** and **6**, mounted with binding posts. These coils are described on page **330** and are recommended for general experiments in Induction . . . . Per set of two **$1.40**

92–115 SOFT IRON U-SHAPED CORE, Figure **3**, for study of bi-polar electro magnets . . . . . Each **.20**

92–117 SOFT IRON ARMATURE, Figure **2**, for use with the above core in the study of electro-magnets. Each **.10**

92–120 SOFT IRON CORE, Figure **5**, single, for the study of electro-magnets . . . . . Each **.10**

92–122 PAIR OF HALF-ROUND CORE PIECES, Figure **4**, for mapping the lines of force in an electro-magnet. . . . . Per pair **.15**

92–125 PAIR OF SLOTTED CARDBOARDS, Figure **7**, for mapping lines of force . . . . . Per pair **.08**

92–130 COMPLETE GILLEY INDUCTION OUTFIT, supplied in box with direction sheets **2.00**

No. 95-30

THE IMPROVED EDUCATIONAL DISSECTIBLE TRANSFORMER

ANY VOLTAGE UP TO 115

No. 95-30

Patent Pending

In the designing of this Transformer we have had in mind an instrument resembling as closely as possible the commercial instrument. In order to make it of the greatest practical use in the laboratory and at the same time serve to teach all of the fundamental forms of Transformers, the dissectible feature is, of course, essential, since a school can hardly afford to buy as many different Transformers as there are types in commercial use.

The instrument which we have produced will be found of the greatest use in demonstrating the principles and laws involved in **self** and **secondary induction,** also the application in commercial work of the **step-up** and **step-down transformer.**

CONSTRUCTION. In form and in methods of construction, the regular commercial instrument as used in lighting and power systems has been followed: — laminated core, taped coil, every feature designed to give the greatest efficiency and greatest durability.

The **dissectible feature,** which enables the student to take the instrument apart, examine and test each part separately, is obtained as follows: —

The **core** is of punchings made from the best electrical sheet iron, punchings arranged in groups of ten, each group being held together by riveting, for convenience in assembling. **Primary coils** are taped and supplied with convenient leads. **Secondary coils** are taped and supplied with leads. These features enable the instrument to be assembled either as a Faraday Ring, Auto Transformer of the shell type, an Auto Transformer of the block or iron-clad type, a Primary and Secondary Transformer of the shell type, a Primary and Secondary Transformer of the block type.

RANGES IN VOLTAGE. The ratios of the primary to the secondary coils are such that a great variety of transformations may be had. If the primary circuit is 110 volts, the voltages drawn from the secondary in various combinations (fully illustrated by diagrams furnished with each instrument) are 7, 15, 30, 60, 220, 235, and 255 volts. Other ranges may be obtained by using a different voltage in the primary line, the ratios of transformation in each case being as above indicated.

For convenience in use the instrument is mounted on a mahogany base with six double binding posts as illustrated.

The instrument serves to teach effectively: —

1. The influence of iron in the core.
2. The magnetic hysteresis.
3. Eddy Currents.
4. Magnetic density.
5. Self-Induction.
6. Back electro-motive force, and many other fundamental principles in alternating current practice not possible with any instrument heretofore offered. Full directions with descriptive diagrams will be supplied with each transformer.

Complete with full equipment for teaching all of the points above mentioned **$11.25**

NOTE: We should be pleased to send a special descriptive circular showing by diagrams many profitable experiments.

PRIMARY AND SECONDARY COILS

95–38 STUDENTS' PRIMARY AND SECONDARY COIL. Height 7½ inches. Consists of two hardwood spools, the outer one provided with a base, and the inner one removable. The inner spool is wound with a few turns of coarse wire and is the "primary," the outer with many turns of fine wire and is the "secondary."

Complete with soft iron core **$3.30**

No. 95–40

95–40 LARGE PRIMARY AND SECONDARY COIL, for the study of current induction. This form, with its primary 6 inches by 1¼ inches and its secondary 2½ inches by 5 inches, must not be confused with the smaller types on the market. We have desired in this instrument to offer the teacher an instrument capable of efficient positive results. This can be secured in a satisfactory manner only by using a large number of windings on the secondary circuit. The wire in each circuit is mounted on separate hardwood spools, and the secondary is mounted on a neatly polished hardwood base. To insure greater rigidity we have added two brass rods connecting the secondary to the base (see illustration below). The wire used is silk covered, and binding posts are neatly polished and lacquered. The soft iron core supplied with the instrument consists of a bundle of soft iron wires tightly moulded by bands to form a nearly solid rod.

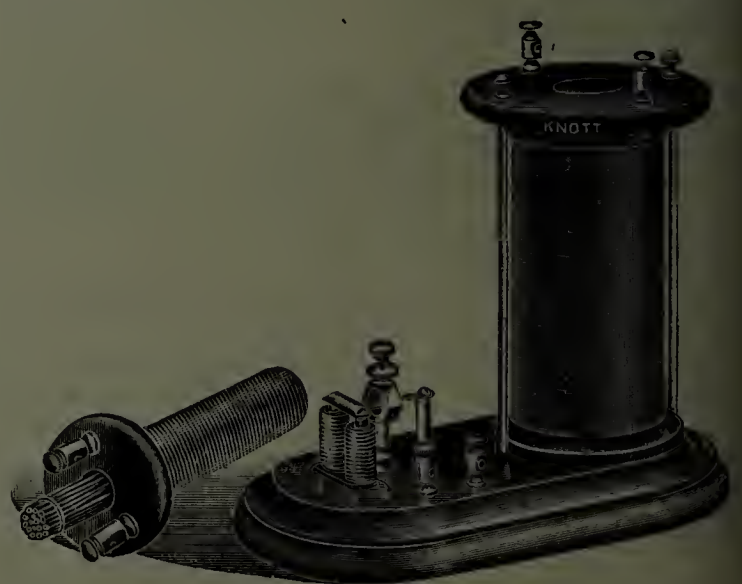
Primary and Secondary Coil complete with iron core **$7.50**

95–45 LARGE PRIMARY AND SECONDARY COIL, similar to above, but provided with vibrator mounted on same base with coil. This vibrator is of the simple electromagnetic type and gives positive interruptions to the current, illustrating the simple induction coil. This instrument is of substantial construction, and all parts are finely polished and finished.

Complete as illustrated **$10.50**

95–50 MAKE AND BREAK INTERRUPTER. It is frequently desired to attach a Make and Break Interrupter to an unmounted primary and secondary coil. The type which we furnish is the same as illustrated on the base of the Primary and Secondary Coil No. **95–45.**

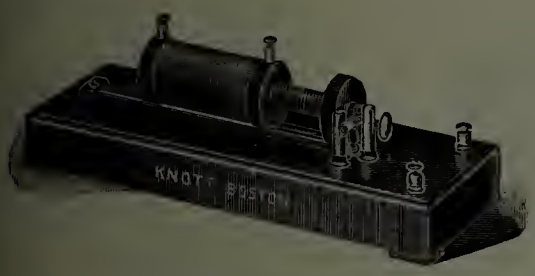
The parts are mounted on a neat wooden base ready for attachment to the terminals of the secondary **3.00**



No. 95–45

INTERRUPTING WHEEL. See No. **90–460.**

INDUCTION COILS



Nos. 95–75 to 95–80

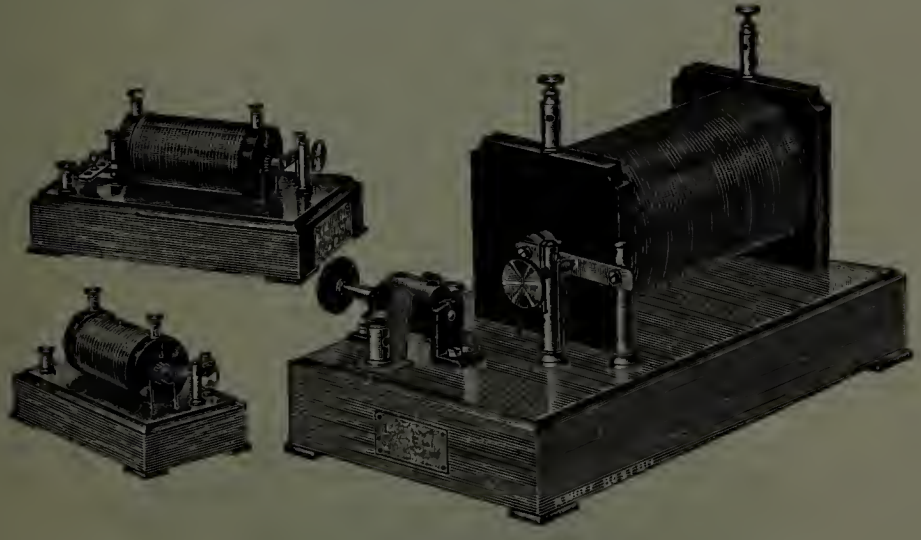
No. 95–95

95–75 **DEMONSTRATION INDUCTION COIL.** This type of coil is of value in the study of the office of the primary in induction coil construction. Both primary and secondary are mounted on a polished mahogany box, but the mounting is designed so that the secondary may be adjusted to enclose varying amounts of the primary.
This instrument is handsomely finished, all brass parts polished and lacquered, and will give a ¼-inch spark **$5.00**

95–80 ——, same as above, but calculated to give a ½-inch spark **8.25**

95–95 **DEMONSTRATION DISSECTIBLE RUHMKORFF COIL.** This coil is constructed so that all essential details of a commercial Ruhmkorff coil may be shown as units and in their relations to the rest of the instrument. Thus the condenser is mounted in a drawer slide. Connections with the secondary are secured through binding posts. The primary may be dissected and taken from the instrument. The make and break and core are of special design calculated to teach the principle, and all connections are fully in the open and may readily be noted at a glance **37.50**

RUHMKORFF COILS



Nos. 95–125 to 95–140

Our small types of Ruhmkorff Coils up to 1-inch spark are construced for us by a prominent European manufacturer. They are of standard quality designed for elementary work.

Ruhmkorff Coils with a capacity of two inches (see next page) are constructed by us in our own factory. We are, therefore, enabled to furnish a product superior in quality to that ordinarily furnished of European make. We secure a greater efficiency and are enabled to place in the hands of the buyer a more finished instrument. The parts of these coils are of the best proportions to give the maximum efficiency and preserve symmetry. Only the best quality of material is used in construction, and all parts are handsomely finished.

We are enabled to guarantee our coils up to their full capacity and warrant them against faulty construction.

EUROPEAN COILS

95–125 **RUHMKORFF COIL,** capacity ⅛-inch spark **$4.25**
95–130 ——, capacity ¼-inch spark **4.90**
95–135 ——, capacity ½-inch spark **7.50**
95–140 ——, capacity 1-inch spark **21.00**

THE "NEW LINE" INDUCTION COILS

Nos. 95–175 to 95–210

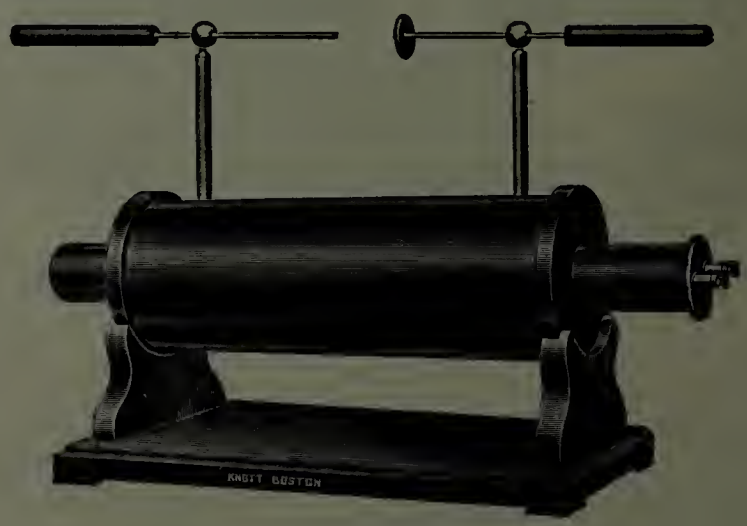
Because of the great improvements in Induction Coil design during the past three years, it is with especial pleasure that we call your attention to our series, ranging from 2 to 18-inch discharge.

These coils are construced according to the latest and best high-tension data. The rigorous demands of X-Ray and Wireless work have rendered valueless coils constructed according to formulæ previously used.

The entire construction of the coil is based on the requirements of heavy discharge rather than length of spark. This is obtained by the use of exceptionally heavy primaries with, of course, the best possible insulation. Every feature has been worked out with the greatest care looking towards the building of a coil which cannot be broken down and which will give the desired results on comparatively low battery power, and in coils designed for use on 110-volt current which will take the rated voltage and amperage without danger.

TESTING. Each coil is subjected to a rigorous test with an overload of 100% to insure against breaking down with ordinary usage.

95–175	**NEW LINE INDUCTION COIL,** guaranteed discharge 2 inches	**$37.50**
95–180	——, same as above, guaranteed discharge 4 inches	**55.00**
95–185	——, guaranteed discharge 6 inches	**75.00**
95–190	——, guaranteed discharge 8 inches	**100.00**
95–195	——, guaranteed discharge 10 inches	**120.00**
95–200	——, guaranteed discharge 12 inches	**145.00**
95–205	——, guaranteed discharge 16 inches	**200.00**
95–210	——, guaranteed discharge 18 inches	**240.00**



No. 95–230

LIQUID INTERRUPTING INDUCTION COIL, for a 110-volt current. In connection with our "New Line" Induction Coils above listed we have worked out an instrument for use on the 110-volt current, especially designed to withstand the entire current from Liquid Interrupter No. **95–252.** It gives a heavy discharge, admirably suited for Wireless, X-Ray, and general induction coil experiments. It may be used with safety, as these coils are designed not to burn out on a 110-volt current.

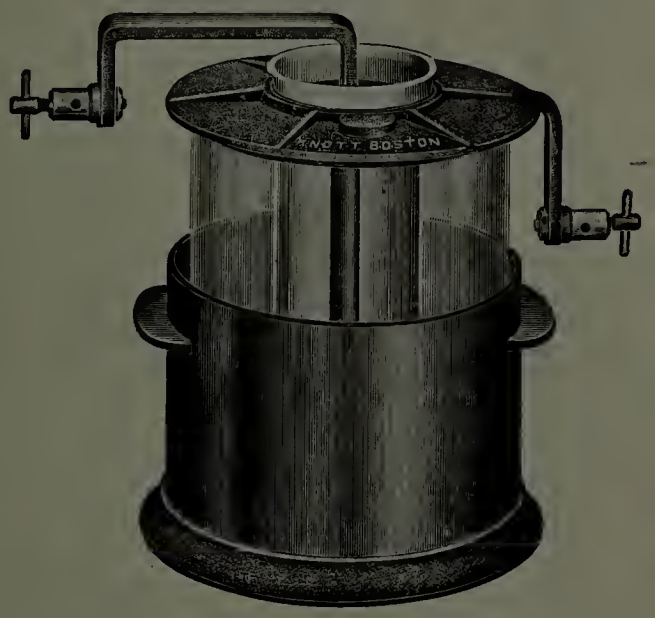
The 7-inch discharge which these coils are designed to give is such as is found most satisfactory for general all-round work in X-Ray and Wireless experiments.

95–225 LIQUID INTERRUPTING INDUCTION COIL, complete with Liquid Interrupter **$73.80**

95–230 ——, same as above, without Interrupter **60.00**

We are listing both coil and interrupter together for the reason that it is somewhat easier to adjust the interrupter to the coil if both are ordered at one time. This adjustment, however, is not absolutely necessary as a careful record is made of each coil and the adjustment can be made at a later date.

THE ELECTROLYTIC INTERRUPTER



Nos. 95–250 to 95–252
Patents Pending

The difficulty with Electrolytic Breaks heretofore used has arisen largely because of the failure of the manufacturers to adjust the size of the gas tube to the line voltage and the amperage which is to be drawn from the break. This difficulty has been fully recognized and satisfactorily met.

We can supply our new design of Electrolytic Interrupter for any voltage and amperage desired. The two forms selected as being most generally serviceable are listed below and are rated according to the Induction Coil capacity with which they are to be used. Please note that they will operate on a direct or alternating current.

CONSTRUCTION. Our Interrupter contains a porcelain cylinder in which the size of the opening is carefully adjusted to the amperage of the current to be drawn. In order to avoid breakage this cylinder is carried on a lead shelf, being part of the inner lead cylinder.

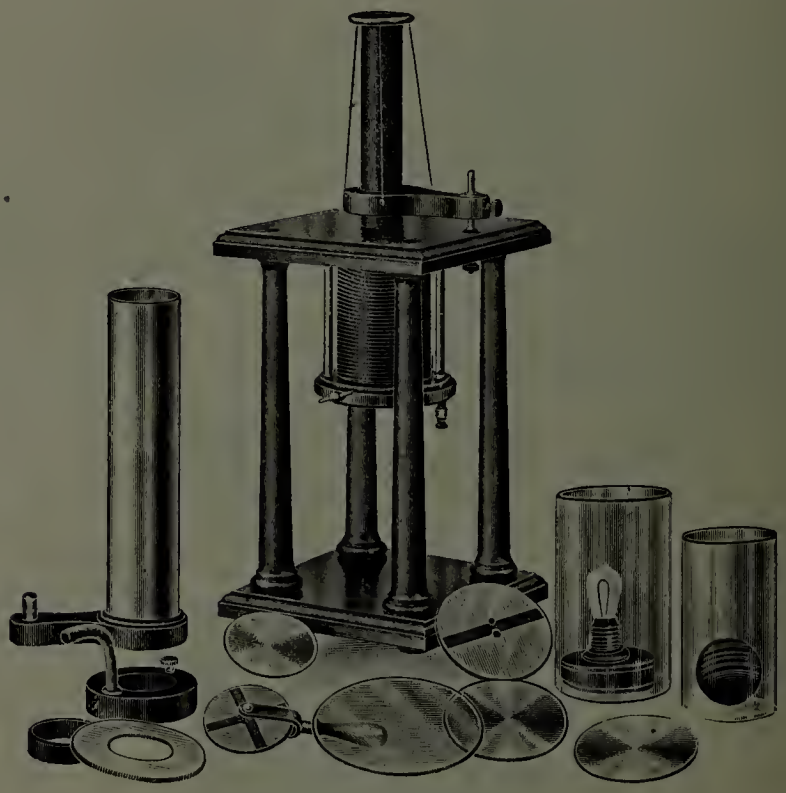
The terminals, as will be noted in the cut, are carried well out on the ends of the long lead bars, bent over and beyond the top of the instrument so as to reduce the objectionable corrosion that is unavoidable when the terminals are above the jar and subjected to the action of the acid fumes thrown off when the Interrupter is in operation.

METHOD OF COOLING. A substantial iron receptacle is provided which acts as a radiator and serves to keep the liquid from overheating. This receptacle also serves to protect the table, floor, or other apparatus in case of accidental breaking of the acid jar.

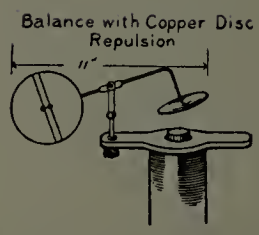
95–250 ELECTROLYTIC INTERRUPTER, type A, for coils from 4 to 6-inch spark **$13.80**

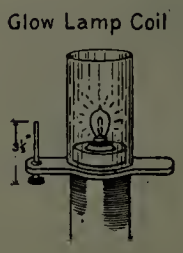
95–252 ELECTROLYTIC INTERRUPTER, type B, for coils form 7 to 12-inch spark **13.80**

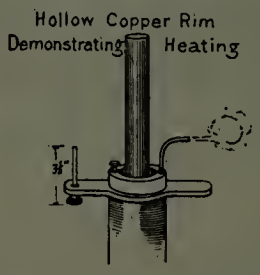
ELECTRO-DYNAMIC APPARATUS FOR ALTERNATING CURRENTS

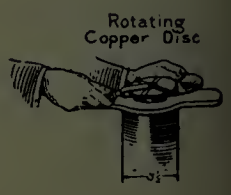


No. 95–260









95–260 ELECTRO–DYNAMIC APPARATUS. This apparatus has been designed for the purpose of showing the repulsion and rotation effects produced by an alternating current. It is designed to operate on a commercial circuit of 110 volts, the alternating current being recommended. It may be used. however, satisfactorily on the direct current if used in connection with our Electrolytic Interrupter No. **95–252.** The apparatus is complete, covering a full set of parts for performing a most instructive series of experiments. A few of these we note herewith: —

Diaphragm made to vibrate in unison with the alternations of the current so as to give out a distinct tone.

Repulsion of a copper disc held in proximity to the iron core on the balance arm.

The rotation of the copper disc, caused by the revolving field.

The rotating ball. A copper ball, placed over the exposed end of the iron core and one-half of the core covered with a copper disc, will rotate. By floating the ball in a jar of water, the rotation becomes rapid.

Lighting of an electric lamp by means of the pulsations given out from the iron core, this being accomplished through the glass jar.

The suspension of a heavy metal ring placed around the iron core.

The comparative repulsion of copper and aluminum rings.

Heating effect in a copper ring, shown by the boiling of a liquid.

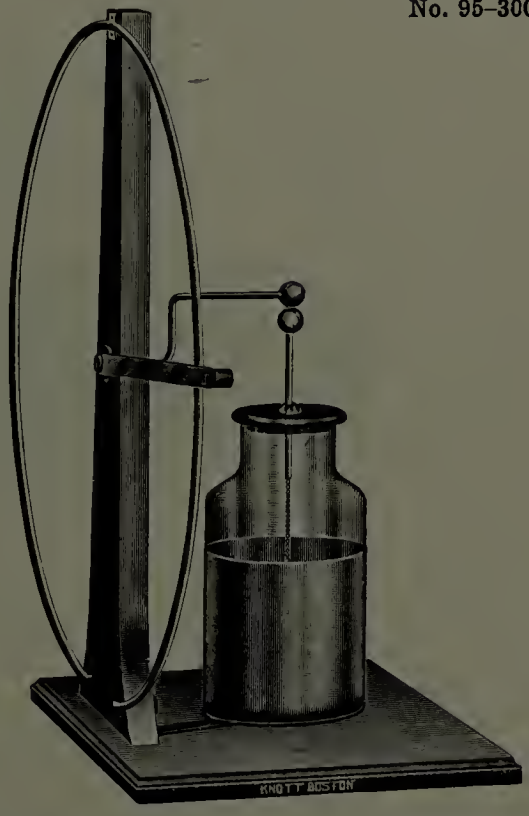
These and many other experiments may be performed with the above apparatus. Their striking character has caused the outfit to be extensively used as a lecture table set.

Complete directions for operating and performing many experiments are furnished with the outfit.

$55.00

95-300 OZONE GENERATOR TUBE, a simple glass therapeutical device known as an Ozone Generator Tube. This instrument has been listed, as it has several features of educational value. In operation the central terminal is connected to a source of High Frequency Current which will fill the air chamber surrounding the central vacuum tube with a fine brush discharge, instantly transforming a portion of the Oxygen of the air into Ozone, which is readily detected by the odor. If desired, Oil of Pine, Starch Solution, or similar Ozone detecting chemicals may be placed in the upper chamber of the device and the air forced through them by simply pressing the bulb furnished. The instrument being made entirely of glass, all operations are clearly visible **$12.50**

No. 95-300



No. 95-310

95-310 SEPARATELY MOUNTED RESONANT LEYDEN JARS, a pair of jars mounted on independent stands, each being fitted with an adjustable discharging circuit, for demonstration of: —

1. Resonance between Electrical Circuits.
2. The Oscillatory Character of the Condenser Spark.
3. Tuning as applied to so-called High Frequency Circuits, Wireless Telegraphy, etc.

They make an impressive and instructive lecture table outfit. In operation one of the jars should be charged by means of a static machine or induction coil, and at each discharge a simultaneous spark will be obtained from the other jar providing that its loop is adjusted to the same positions as the loop on the first. Changing the size of the loop on either of the jars without altering the other will throw them out of tune, and the charge on one will be much less than on the other. When in tune the two parts of the outfit may be removed a considerable distance apart, thus showing in a very clear manner the wonderful sensitiveness of resonsant circuits.

The outfit is usually equipped with one-quart Leyden Jars, but jars either larger or smaller may be used, if at hand, thereby greatly increasing the educational value of the device, for it can be shown that to obtain resonance the value of the condenser times the inductance or loop must be the same; i. e., a large jar discharging through a small part of the loop of conductor will energize the other or smaller jar through a larger part of its circuit, etc.

Separately Mounted Resonant Leyden Jars, complete as illustrated **$14.50**

HIGH FREQUENCY

Experimental work with high frequency currents has been impeded by the lack of well-designed apparatus in marketable form. The coils which are listed on the following pages are the results of fifteen years' experience in the construction of high frequency apparatus, the first coil of this general type being built by us in the early days of high frequency work. It has taken years of careful study, however, to learn how best to combine the elements embodied in these instruments so as to produce a compact, safely handled coil giving adequate power with a range of adaptability which would especially fit it for a scientific study of high frequency phenomena.

No. 95–325

UNI-POLAR HIGH FREQUENCY COIL

TEN-INCH CONTINUOUS DISCHARGE

No. 95–325

This instrument is a most striking outfit for general lecture work and for exhibition. It is built on lines that have proven successful in the highest grade instrument construction. Not only does its peculiar compact design protect the working parts when not in use, but it also affords an instrument that is readily transportable from place to place. Although when folded it occupies 16¾ × 8½ × 9⅝ inches, when open, it is not only large, but all the vital parts are held at a considerable distance apart, so that a very large amount of energy can be handled without overloading or subjecting the various parts to an undue strain. The instrument is entirely self-contained and after being connected to the lighting circuit by means of a cord and plug, it is ready for use.

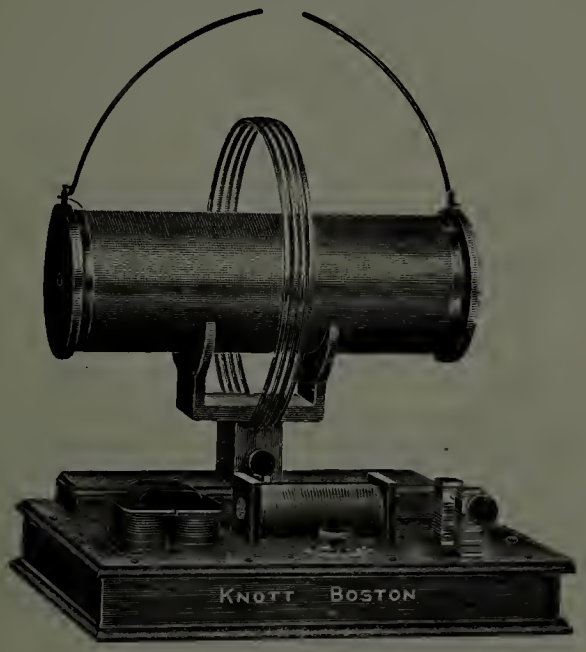
Showing Coil Folded

We desire to call particular attention to the construction of this coil. Its design has been the result of careful investigation, and the expenditure of a great amount of time and money. We believe that there has been attained a perfection not reached by any instrument of its class. It comprises no new or untried parts or material. We have watched its development and operation for several years, and when thoroughly convinced of its merits, utility, and "standing-up" qualities, made arrangements with its inventor for its sale in educational institutions. We are enabled to fully guarantee this coil against accidental "break-downs" and against "burn-outs."

Designed for alternating current, complete with carrying strap, connecting cords and Edison plug, and with pamphlet descriptive of care and use **$200.00**

No. 95–335

HIGH FREQUENCY INDUCTIVE APPARATUS



No. 95–335

This instrument represents a radical departure from the types of high frequency coils previously offered. By combining the open type of resonator commonly used in European laboratories with the closed core type of transformer and silver spark gap, unusual efficiency is obtained, producing an instrument particularly well adapted to the study of alternating and high frequency phenomena.

Provision has been made for varying the value of both the condenser and inductance. Currents of varying frequencies can thus be produced, enabling comparisons to be made between the effects produced by changing either capacity or inductance.

Both the secondary and the oscillator are easily removed. Also, the entire resonator may be readily taken off from the instrument, permitting experimental apparatus to be attached to the low voltage (approximately 10,000 volts,) high frequency primary current.

PURPOSE. — This apparatus is designed for a comprehensive study of the high frequency field, including wireless telegraph waves and kindred subjects. It may also be used with great satisfaction to excite all types of vacuum tubes and will produce X-Rays of surprising power and penetration.

USE. — It is designed to be connected to a commercial alternating current of 110 volts and will furnish a discharge of any desired value up to its full capacity, which is about 12 inches. Its ease of control and great range of usefulness make it of particular value in general laboratory experiments and experiments on the scientific study of Electro-therapeutics.

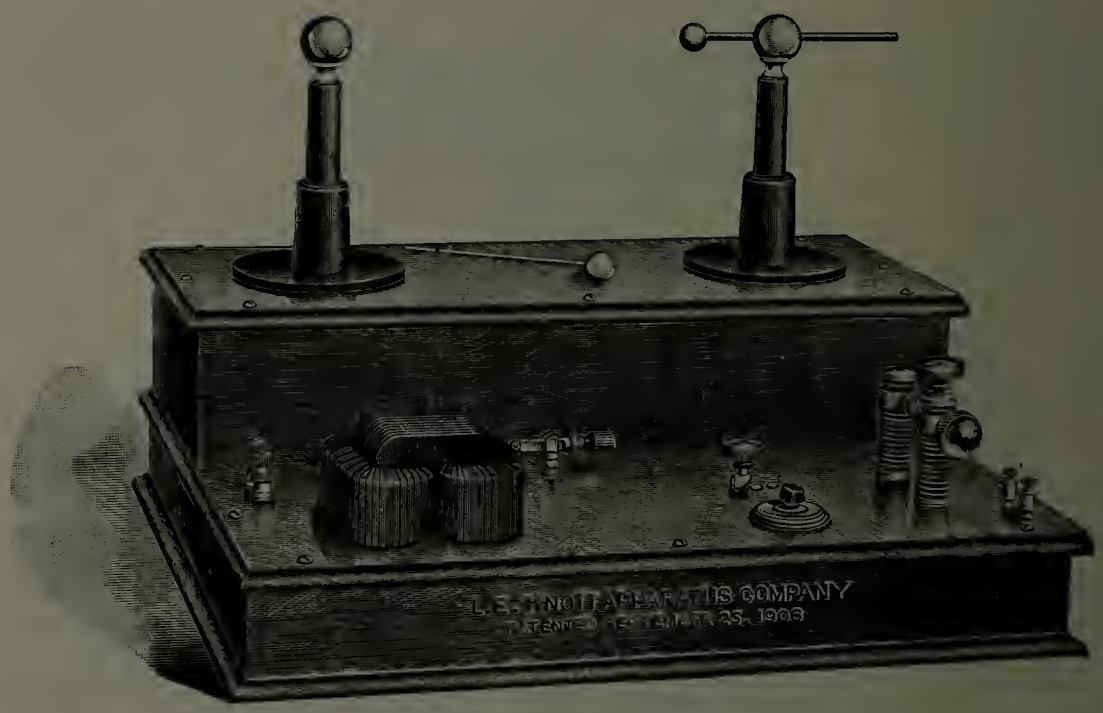
The mounting is mahogany, the condenser of mica and the secondary oscillator is wound on a large mica tube. The highest grade material only is used, — the workmanship the best that mechanical skill can produce. **$160.00**

No. 95–340

BI-POLAR HIGH FREQUENCY COIL

TWELVE-INCH CONTINUOUS DISCHARGE

Designed for Alternating Current



No. 95–340

95–340 BI-POLAR HIGH FREQUENCY COIL. This coil is designed to furnish a powerful high frequency discharge, suitable for X-Ray work and general experiments requiring high voltage. It is of ample proportions and entirely self-contained. It is of the bi-polar type, i. e., each terminal is active and throws off an abundance of energy when in operation. The instrument is fitted with an experimental circuit for demonstrating the laws and performing the many interesting and instructive experiments pertaining to high frequency phenomena.

Our coils are built for service, only the best of material being used in their construction. They are built on lines that positively avoid the danger of expensive "break-downs," such as are met with in the old style of induction coils. Each coil is fully guaranteed against mechanical and electrical imperfections.

The instrument is finely finished throughout and is furnished in a polished magohany case. All metal parts are neatly polished and lacquered.

Complete with connecting cord and Edison plug and with complete directions for care and use. . **$140.00**

95–375 HIGH FREQUENCY PHENOMENA APPARATUS. For the convenience of teachers who desire to give a course in high frequency currents we have designed apparatus capable of performing all the experiments outlined on the following page and many others incapable of adequate illustration. This line of apparatus is well made, and finished and guaranteed satisfactory in every respect. All the instruments have been tested with the previously listed coils and the instructive and interesting results obtained have fully warranted a place in our catalogue.

High Frequency Phenomena Apparatus sufficient for performing all the experiments outlined on the following page. In neat wooden case but without X-Ray Tube. **35.00**

HIGH FREQUENCY PHENOMENA

ILLUSTRATING TWENTY-FIVE OF THE MANY POSSIBLE EXPERIMENTS

Melting wire held in hand

1

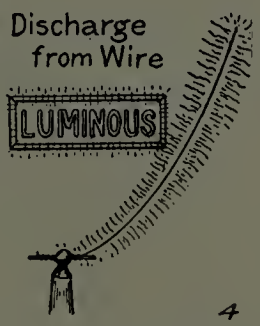
Brush Discharge from Hand

2

Brush Discharge Ozone Generator

3

Discharge from Wire



4

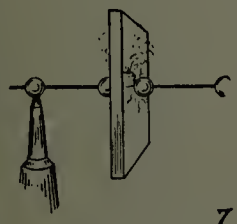
Molecular Bombardment

5

Transformation into Static Electricity

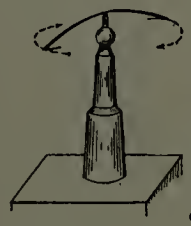
6

Destruction of Dialectric



7

Electric Whirl

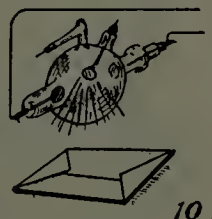


8

Effect of Air Blast on Discharge

9

X-Rays Radiography Fluoroscopy

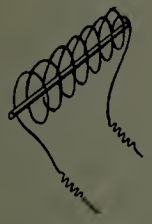


10.

Lighting Vacuum Tube without connection Electro Static Field

11

Hysteresis Heating Iron

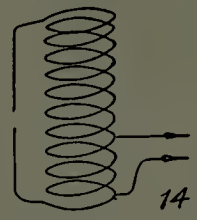


12

Self Induction Marked Drop in Voltage

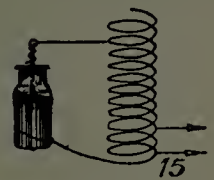
13

Stepping up Voltage with forced oscillations in self induction helix



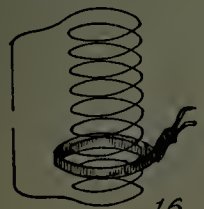
14

Resonance in Helix



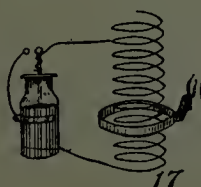
15

Primary and Secondary Induced Forced Currents



16

Primary and Secondary Induced Resonant Currents

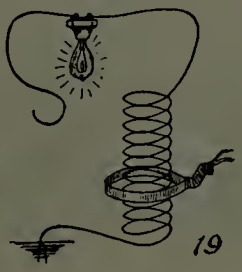


17

Lighting Commercial Lamp through Body

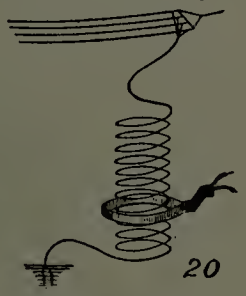
18

Lighting Lamp on one wire



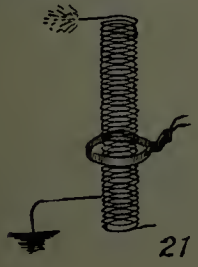
19

Wireless Telegraphy



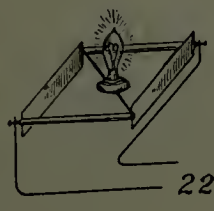
20

High Voltage Resonant Helix



21

Surface Resistance

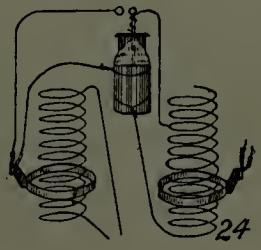


22

Ultra Violet Light Fluoresence

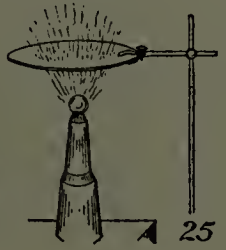
23

Very High Frequency



24

Radiation through Dialectric



25

COMMERCIAL WIRELESS APPARATUS

The educational value of Wireless Telegraphy and High Frequency Apparatus cannot be overestimated. Holding the attention of the student and scientist alike with a wonderful fascination, it has been the means of awakening an interest in school work where all other devices have failed.

It is not unusual today to hear pupils in the elementary grades speaking in a comprehending manner of wave fronts, vibrations, resonance, attuned circuits, potentiometers, variable condensers, and like subjects and phenomena, that a few years ago were understood only by advanced students of science. It can hardly be realized that students in the grammar schools have been enabled through their interest in this class of apparatus to so master the subject as to be capable not only of designing and building working outfits, but also of reaching such a degree of proficiency in operating them as to be employed as expert operators in commercial stations.

Wireless apparatus should be installed in every school taking up the study of Physics, for it will be found to be the one set of apparatus in the laboratory that will hold the students' attention. Clubs will be formed, and the students will take the greatest interest in getting into communication with neighboring schools fitted with apparatus, and one and all will endeavor to excel in proficiency and understanding of the subject.

The installation of apparatus is extremely simple, requiring but little more thought and time than the installation of an ordinary telegraph instrument. In many sections of the country the apparatus is interesting in that it furnishes a ready means of obtaining standard time which is given out daily from the important government stations. So much apparatus of purely amateur design and construction has been offered for school work that we feel that the success of the instruction in this field has been seriously handicapped. For this reason we have decided to offer the only standard types of commercial instruments, built by manufacturers of the widest experience in installing commercial outfits.

No. 95-400

95-400 COMPLETE SENDING OUTFIT. This is a compact outfit comprising Transformer, Condenser, Helix, Spark Gap and Key mounted in and on a finely finished mahogany cabinet. It is shipped ready for use and has but to be connected to any convenient source of 110-volt alternating current and a suitable antenna.

Complete as above described **$44.00**

No. 95-405

95-405 COMPLETE RECEIVING SET. This is a combination of instruments mounted in a well-finished mahogany cabinet with hinged cover. This set includes a Ferron Detector, a Receiving Transformer, a Fixed Condenser, a Rotary Variable Condenser, and a 2000-ohm Telephone Head set. Binding Posts are provided for antenna, ground and receiving connections.

The completness, accessibility and efficiency of this instrument will appeal to any one interested in the subject.

Complete Receiving Set **$40.00**

SEPARATE WIRELESS UNITS

No. 95-410

We list below a line of high-grade separate units for the benefit of those who are already partially equipped or who may wish to construct for themselves a part of their wireless apparatus. The design of the units is of the very latest commercial types and such as will appeal to those desiring to do high-grade work in the wireless field.

SENDING APPARATUS IN SEPARATE UNITS

95-410 **TRANSFORMERS.** High efficiency, high power, low heating factors and reliable service. Each instrument is mounted in mahogany cabinet, the secondary sections being instantly removable without injuring the transformer. The primary may also be drawn from the tube without interfering with the secondary.

	a ¼	b ½	c 1 K. W.
Each	$33.00	49.00	67.00

95-415 **HIGH POTENTIAL CONDENSERS.** Each condenser is mounted in a box with separate connections brought out from each unit so that the capacity may be varied by connecting in various sections. This form of condenser will save an enormous amount of energy which is frequently lost in the condenser system. It will conserve the great power of our transformers as no other condenser can. With this type of condenser the efficiency of a station is often doubled.

	a ¼	b ½	c 1 K. W.
Each	$12.40	24.50	48.00

No. 95-420

No. 95-430

95-420 **HELIX.** This helix is the one employed in No. 95-400 Transmitting Set. It is simple and rugged in construction, of unusual efficiency, employing as it does edge-wise wound copper strips. The base is of finished mahogany; supported on hard rubber. Three clips are provided for varying the degree of coupling . $6.75

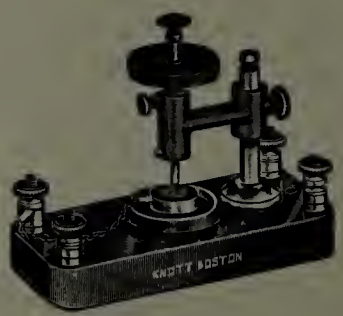
95-425 **OSCILLATING TRANSFORMER.** Our ¼, ½ and 1 K. W. sending Inductances are of the inductively coupled type, having the right amount of coupling to produce a high defined wave and perform close tuning at the receiving station. The primary is of copper ribbon wound spirally. The secondary is of copper ribbon wound on especially prepared drums. Both circuits have variable inductances which insure absolute resonance between the two circuits, insuring the radiation of a greater amount of energy in the form of waves, instead of the energy being wasted in heat at the spark gap. This Oscillator is designed for the production of wave lengths of from 600 amperes to 950 amperes efficiency.

	a ¼	b ½	c 1 K. W.
Each	$21.00	21.00	44.00

95-430 **ADJUSTABLE SPARK GAPS.** No part of a sending set is more likely to cause loss of energy than a poorly constructed spark gap. In many instances efficiency is cut down one-half through loss at this point. In our instruments we use an especially prepared zinc electrode, capable of withstanding heavy currents 5.50

RECEIVING APPARATUS IN SEPARATE UNITS

DETECTORS

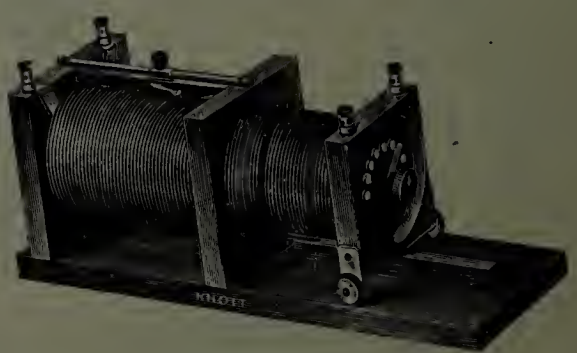


No. 95–435
Patented

No. 95–440
Patented

95–435 SILICON DETECTOR. This form of Detector is well known to all who are interested in wireless apparatus, and some of the longest records have been made with this type of instrument. It is fully guaranteed and furnished to us by a manufacturer especially licensed by the inventor . . . **$6.50**

95–440 IMPROVED FERRON DETECTOR. The new Ferron Detector is made up of a metallic crystal held in a nickeled cup, mounted on the usual form of detector stand. An exceedingly fine adjustment of pressure is easily obtained by means of a triple spring operated by a milled head rubber rod. Mounted on substantial marble base 5½ × 3 inches. This Detector is simple and operates best without either Potentiometer or battery **6.25**



No. 95–445

95–445 TUNING COIL of the **loose couple type.** This instrument has been especially designed for educational institutions where it is desirable, in order to show the construction of the essential working parts, to withdraw entirely the primary from the secondary coil. Special provision has been made for this so that it may be drawn fully from the secondary and inserted without danger of binding. The adjustment is easy and positive. The primary of the coil is of unusual capacity, enabling the shortest and longest wave lengths used by commercial stations to be received with a comparatively small antenna, and without the use of additional inductances or condensers. The secondary is made much larger than is usual and mounted on pivoted wheels **$15.00**

No. 95–455

95–450 HEAD BAND RECEIVERS. Double, 2000-ohm resistance . . . **12.00**

95–455 FIXED CONDENSER. The most approved methods of connecting a modern receiving station require a small condenser of fixed capacity in addition to the variable condenser used in tuning purposes. It is mounted in a nickel-plated brass cylinder fitted with hard rubber top carrying binding posts. Its capacity is approximately .003 M. F. **2.30**

VARIABLE AIR CONDENSERS. See page **388.**

ELECTROLYTIC RECTIFIERS

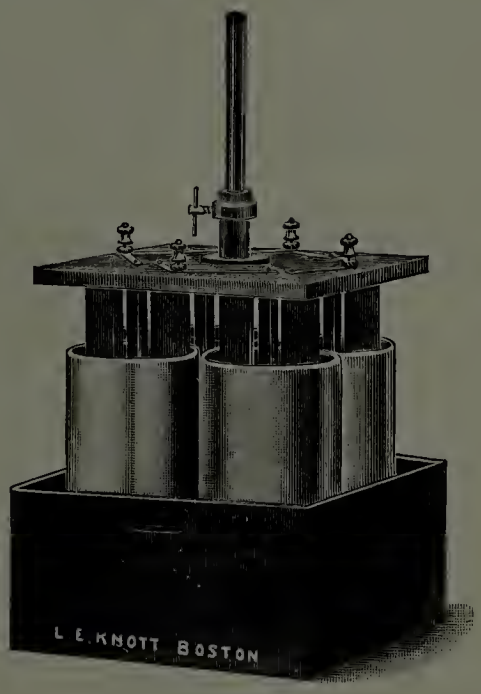
95–485 ELECTROLYTIC RECTIFIER, Nodon valve type, designed for use on 110-volt alternating current, giving a direct current of the pulsating form, but one in which the negative part of the wave is entirely cut off, so that for most purposes this transformed current takes the place of a direct current of equal voltage. The charging of storage batteries, experiments in electrolysis, charging of electromagnets, complete series of experiments showing the mutual attraction and repulsion of currents, etc., may be performed with this current.

The valve here illustrated is of substantial construction, jars, lead plates, aluminum rods of generous proportions, slate top and connectors, substantial iron rod support and wooden carrying case.

Full directions for connections and use furnished with each instrument.

Large amperage may be drawn from this instrument, but for brief periods only, owing to the fact that no adequate arrangements have been made for radiating the heat.

Complete **$14.75**



No. 95–485

No. 95-490
Patent Pending

95–490 THE NEW MULTIPLE RANGE SELF-COOLING RECTIFIER, with ammeter, designed for use on 110-volt alternating current and to deliver a **direct current** of **varying voltages.** As ordinarily furnished, **3, 6, 9,** and **12** volts have been provided for, being the ranges most generally useful in laboratory work. In addition to these a **12-volt alternating current** may also be drawn. As will be noted from the illustration, the instrument is provided with an ammeter so that the exact consumption on the direct current circuit may be noted constantly.

The terminals on the top of the case are connected to various sections of the transformer, each clearly marked so that the user can tell at a glance what voltage he is drawing.

General construction. Owing to the care which has been taken to properly dissipate the heat, large amperage may be drawn from this instrument continuously. The metal case is made with radiating vanes, the case itself serving as one of the electrodes, so that the heat generated is taken care of by conduction and radiation as fast as produced.

This outfit will be found not only much more convenient to use than the electrolytic rectifiers of the type No. **95–485,** but is also much more efficient. The fact that multiple voltages can be drawn enables it to fill a need in laboratory work which has long been felt. These instruments should be provided in every laboratory where a direct current of low voltage is not already provided for.

Complete directions furnished with each instrument.

Complete with ammeter, mounted as shown in the illustration **$38.00**

ROTARY CONVERTERS

Nos. 95–500 to 95–506

Our Rotary Converters are of the same high quality as are our Generators and Motors listed in Section **97.** The conversion of the Direct to the Alternating current is accomplished with the highest efficiency output. They are guaranteed against mechanical and electrical imperfections.

Prices include Automatic No-voltage Release Starting Box.

	Output Watts	Speed	Price Volts Input 110	220
95–500	75	3600	**$50.00**	**$53.00**
95–502	100	3600	**52.50**	**55.50**
95–504	150	3600	**55.00**	**58.00**
95–506	250	1800	**60.00**	**64.00**

MOTOR GENERATORS

Nos. 95–510 to 95–520

These Motor Generators are intended for those schools which have an available Alternating Current and which desire a Direct Current. Our line listed below is of standard quality guaranteed against mechanical and electrical defects.

Prices include suitable rheostat when needed.

	A. C. Motor, 60 cycle, single phase 1740 RPM, 110 or 220 volts H. P.	Generator Watts	Price
95–510	⅙	60	**$80.00**
95-512	¼	120	**96.00**
95–515	½	175	**142.00**
95–517	½	250	**165.00**
95–520	1	500	**215.00**

INDUCTANCE AND CAPACITY APPARATUS

SELF-INDUCTION APPARATUS

Nos. 96–10 to 96–40

Nos. 96–50 to 96–52

STANDARD SELF-INDUCTION COILS. The knowledge of exact measurements in the matter of self-induction and capacity is of the greatest importance in setting up and in the use of machines, measuring instruments, and apparatus operated by alternating currents, as in installing of telegraph and telephone apparatus, cables, and circuits of all kinds. By the use of standard self-induction coils and simple measuring appliances it is possible to determine these values very exactly.

The self-induction coils below listed have been prepared in accordance with the principles laid down by the Reichsanstalt. They are spools of wire of known self-induction wound upon cylinders of serpentine, wholly free from iron and immovably fixed upon these cylinders.

These spools are so encased in a vulcanized rubber covering that they are protected against injury from the outside. By avoiding all metal parts except very small clamps, and by the divisions of the turns of the coil the presence of eddy currents is effectually avoided.

The standards are tested with great care to .002 of their stated value.

96–10 **STANDARD SELF-INDUCTION COIL,** capacity 1 Henry . . . . . Duty Free

96–12 ——, capacity 0.5 Henry . . . . . " "

96–14 ——, capacity 0.1 Henry . . . . . " "

96–15 ——, capacity 0.01 Henry . . . . . " "

96–17 ——, capacity 0.001 Henry . . . . . " "

96–19 ——, capacity 0.0001 Henry . . . . . " "

96–30 **STANDARD SELF-INDUCTION SPOOLS,** same as above, but wound on marble spools; capacity 1 Henry . . . . . Duty Free

96–32 ——, capacity 0.5 Henry . . . . . " "

96–34 ——, capacity 0.1 Henry . . . . . " "

96–36 ——, capacity 0.01 Henry . . . . . Duty Free

96–38 ——, capacity 0.001 Henry . . . . . " "

96–40 ——, capacity 0.0001 Henry . . . . . " "

96–50 **AYRTON and PERRY'S VARIABLE STANDARD OF SELF-INDUCTION,** reading directly to Millihenrys, range from 4 to 40 Millihenrys. Wood mounting . . . . . Duty Free

96–52 ——, same as above, but constructed of ebonite . . . . . " "

96–60 **ADJUSTABLE INDUCTANCE.** These inductances are made up of copper wire wound on a threaded hard rubber tube, — a construction that has been found to give excellent results both mechanically and electrically. A smooth-acting slide permits any desired amount of the wire to be placed in circuit, and a scale on the slide support gives the value of the portion in use.

These inductances will be found well suited and convenient to use in connecton with High Frequency currents and Wireless Telegraph outfits.

Capacity 1000 Microhenrys $15.00

96–65 ——, same as above, capacity 5000 Microhenrys 26.00

Nos. 96–60 to 96–65

CONDENSERS

No. 96–117

Nos. 96–135 to 96–140

96–105 CONDENSERS, paper and tinfoil rolled type. These condensers have a guaranteed capacity, and the average insulation resistance of 100 megohms and not less than 50 megohms per micro-farad.

	a	b	c
Capacity	½	1	2 M. F.
Each	$1.20	1.30	2.10

96–110 SUBDIVIDED PAPER CONDENSER, ½ to 2 M. F. by ½ M. F. steps. Enclosed in polished wooden case **$6.75**

96–115 SUBDIVIDED PAPER CONDENSER, excellent grade, capacity one micro-farad, subdivided into four steps, — 0.1, 0.2, 0.2 and 0.5 M. F. Enclosed in polished wood case as illustrated under No. **96–117** **32.40**

96–117 ——, same as above, but capacity 2 M. F. subdivided into five steps, — 0.1, 0.2, .0.5 and 1 M. F. **40.00**

96–125 MICA CONDENSERS. These condensers are constructed by an improved process in which the mica leaves are silvered on both sides. This direct deposit of metal without any foreign substance permits of the full dielectric properties of the mica. It will be noted also that the deposit of silver adhering so closely to the mica forms a perfect condensing surface. It will be found by actual tests that the stated capacities remain constant.

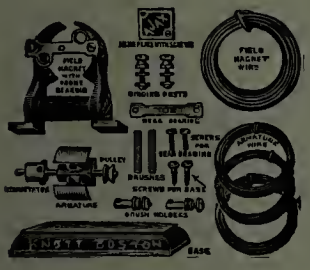
	a	b	c	d
Capacity	0.1	0.2	0.5	1 M. F.
Each, Duty Free	$22.40	30.00	38.50	59.00

96–135 VARIABLE AIR CONDENSER. This is a standard instrument constructed of the highest quality material and of first-class workmanship throughout. The vanes are of aluminum, and the moving system works perfectly without interference of the plates or other objectionable features commonly met with in instruments of cheaper construction. The top is of the best grade hard rubber, insuring high insulation and durability. A binding post is provided connecting to the case for grounding in experiments where the utmost accuracy is required. These condensers will be found of great usefulness in wireless telegraphy and in experiments with currents of high frequency. Capacity .001 M. F. **28.00**

96–140 ——, similar to above, but with a capacity of .005 M. F. **42.00**

ELECTRO-DYNAMIC APPARATUS

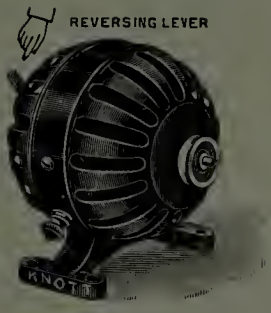
DYNAMOS AND MOTORS



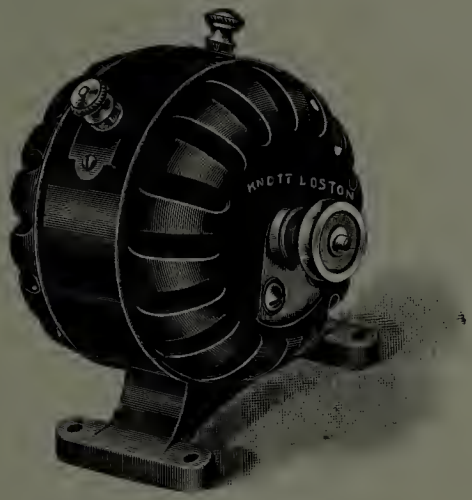
No. 97–10

No. 97–15

No. 97–25



No. 97–30



No. 97–40

97–10 MOTOR PARTS, complete parts for assembling a working motor. The popularity of the outfit above illustrated has demonstrated its efficiency as a pedagogic instrument. All parts ready to wind and assemble are enclosed with simple directions in a neat cardboard box. These parts and directions may be placed in the hands of any ingenious pupil who may readily assemble a motor for himself **$1.25**

97–15 SIMPLE MOTOR. This motor though simple is well and substantially made. It is finished in black enamel with nickel-plated trimmings; mounted on polished wood base. It weighs about 1 pound and occupies a space 3 × 3¼ × 4 inches.
It will run efficiently on a single battery cell **1.50**

97–17 SERIES WOUND DYNAMO, same simple and substantial structure as above. Effectively used with above in combining a simple Motor Generator **2.00**

97–25 STANDARD MOTOR. This motor is built for efficiency. It is designed to operate on two or three cells of battery. Will run about 2200 R. P. M. with average load on a current of 2 amperes at 4 volts.
Finished in black enamel with brass terminals. Weighs about 1½ pounds; occupies a space about 3½ inches square **3.25**

97–30 REVERSING LEVER MOTOR. This motor is similar in design to No. **97–40,** though built on a smaller plan. It is wound for battery current only and runs to full efficiency on two or three dry cells. Stands about 3¼ inches high and weighs about 15 ounces.
A feature of this motor is the reversing lever designed to start, stop, and reverse the motion of the armature **3.75**

97–40 AIR-COOLED MOTOR. This small motor, standing 3⅜ inches high and weighing 20 ounces, is built on the lines of large machines. With the exception of the base no cast iron is used in its construction. The field is made of the best charcoal iron, annular field coil carefully taped and shellaced. The armature is laminated and slot wound. It is provided with self-lubricating bearing so constructed as to always be in perfect alignment, the cups having covers. The commutator segments are of hard copper carefully insulated with mica. Brushes are self-adjusting. Steel armature shaft fitted with grooved brass pulley ⅝ inch in diameter. This motor is handsomely finished throughout, the frame and base being finished in black enamel. It is highly recommended as a most powerful battery motor **4.50**

No. 97-60

97-60 STUDENTS' MOTOR GENERATOR for the study of the construction and operation of a simple dynamo and motor. This is a complete power station in the smallest practical size for students' laboratory work. The general design is such as all doubtless are already familiar with, but made of much higher quality of workmanship, and consequently more efficient.

The motor is wound for a 4-volt battery current, the dynamo is series wound, and proportioned to give the best possible results as a generator, notwithstanding its small size. The dissectible features of both dynamo and motor are important for both laboratory instruments. They will be found valuable educational instruments in studying the complete transformation of electrical energy from the battery through the motor, dynamo, and galvanometer.

Both instruments are mounted and clamped to a neatly polished wooden base and direct connected by a short belt. With the use of this combination a student is able to compare the parts of the dynamo with the corresponding parts of the motor, to observe points of similarity and points of difference.

The instrument utilizes our popular Turner Base and Clamp which binds both motor and dynamo in correct alignment in a simple and efficient manner **$3.95**

97-62 TURNER AND HERSEY BED CLAMP for small power station. This base, as supplied in above apparatus, is designed for easy and effective coupling of a motor and dynamo. In students' experimental work it is necessary that the two units be held rigidly in position, but that sufficient adjustment be allowed for readily tightening the belt. The metal clamps provide an easy and effective method of regulating the distance and of tightening the belt.

Complete **45**

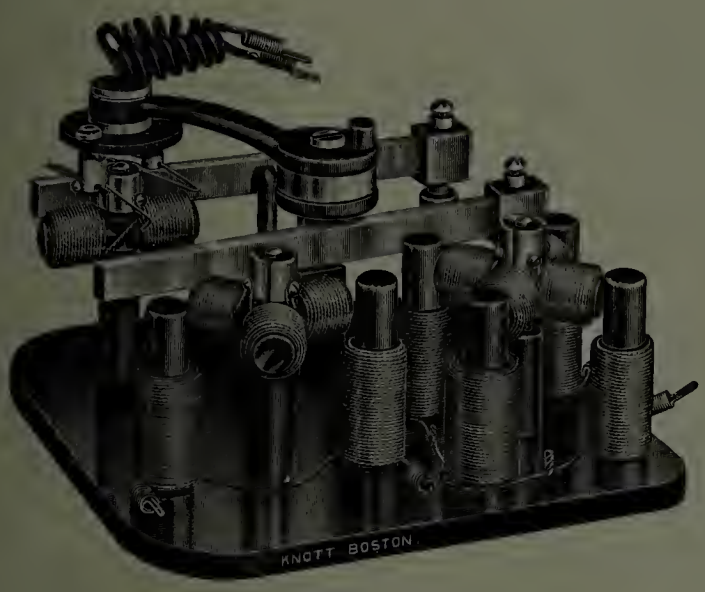
97-70 DYNAMO-MOTOR, field of soft gray iron, armature — eight sections of the laminated tunnel drum pattern, shunt wound with silk enameled wire, commutator eight sections amply insulated with large carrying capacity, brushes of best pattern and quality, bearings of brass with large oil cups, finish bright enamel and nickel-plate, mounted on polished wood base 4¾ × 5½ inches.

No. 97-70

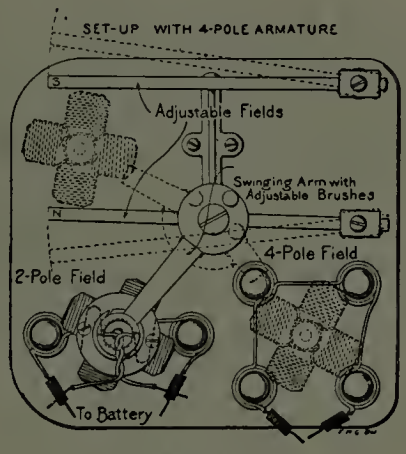
As a Dynamo its output at full speed of 3000 to 3200 R. P. M. is about 30 watts (12 volts and 2.5 amperes). It will be found very useful for furnishing current for many experiments in the study of Electricity and Magnetism. It will charge a six-volt 40-ampere-hour storage battery in 12 hours.

As a Motor it operates on 6 to 12 volts of battery current, giving about 1800 R. P. M. at 8 volts and 2500 R. P. M. at 12 volts. It will develop about 1/25 H. P.

This Dynamo-Motor is furnished with a pulley 1½ inches in diameter, V-groove for a 5/16-inch round belt **7.75**



No. 97-100



No. 97-100 (Fig. 1)

2-POLE ARMATURE
Fig. 2

3-POLE ARMATURE
Fig. 3

4-POLE ARMATURE
Fig. 4

97-100 MOTOR DYNAMO DEMONSTRATION APPARATUS.

From an educational point of view, teachers will appreciate the **open construction** and the ease with which the student may see at a glance the various **poles** of **either type of dynamo or motor,** and in consequence be free from the perplexing problem of determining the exact position of the pole. Some of the points that may be easily studied by the student are briefly outlined as follows: —

1. The two-pole Magneto.
2. The two, three, or four-pole Armature in a two-pole field.
3. The effect of varying the strength of the field.
4. Shunt-wound Motors having like or unlike number of armatures and field poles.
5. Series-wound Motors having like or unlike number of armatures and field poles. (This point is rendered especially easy since all the armatures are interchangeable with all the field systems so that they are easily combined in any desired manner.)
6. A study of the neutral point.
7. A study of the effect of changing the direction of the current in either armature or field. Many other experiments applicable to the Dynamo and Motor may be readily performed. Price complete with 3 Armatures,
   6 Field Coils,
   2 Bar Magnets **$3.85**

97-105 METAL MOUNTED IMPROVED ST. LOUIS MOTOR, with Improved Brush Carrier and Armature.

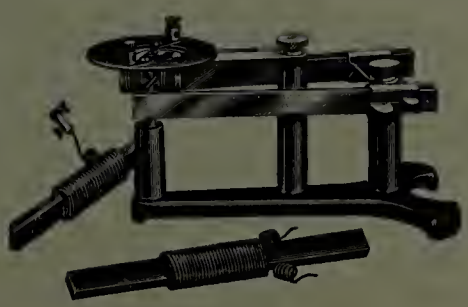
This apparatus is an improved form of the apparatus known as the St. Louis Motor. It may be used as a dynamo or motor. Although similar to No. **97-100** in its application to principles of dynamo and motor construction, it is limited in range of experiments possible. It serves effectively, however, to teach with permanent field magnets, —

1. Strength of magnet field at different distances from armature.
2. Effect of two like and effect of two unlike poles; with electromagnet field, series and shunt dynamo.

It is a simple and effective means in individual laboratory work of making simple and clear, —

1. Polarity of armature at different points in its revolution.
2. Direction of current in armature and field.
3. Commutation, position of armature, commutator and brushes.

Complete as illustrated, with permanent and electromagnet attachments **$2.80**



No. 97-105

No. 97-115

GILLEY GRAMME MACHINE

No. 97-115 Fig. 1

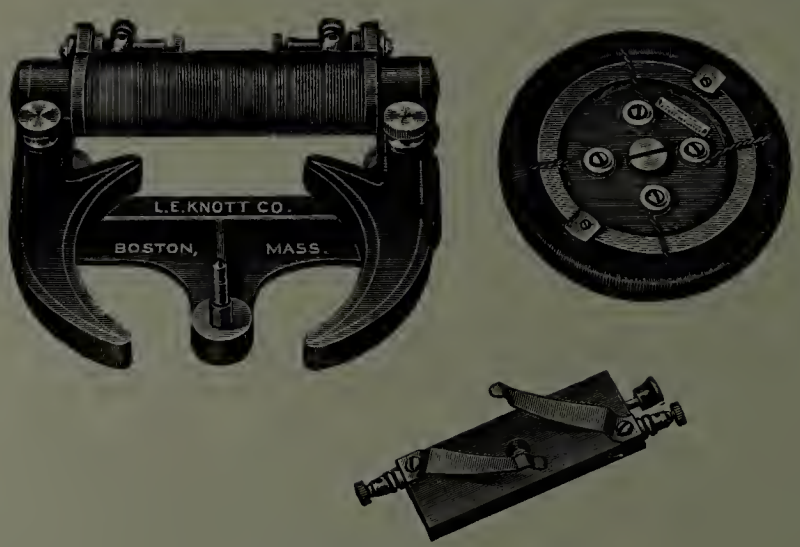
The Gramme Machine represents a type of generator now generally used in large units for power and lighting stations. The Gilley Gramme Machine is a modification so worked out that the lines of force may be easily plotted by the compass and filings method.

No other apparatus has yet been designed with which it is possible to show the lines of force in a working model of the dynamo and motor with the armature in position and in actual operation. Both the field and armature are designed and made in flat form, so that the upper surfaces of both are level, permitting the paper or glass upon which the lines of force by the filings method are to be mapped to take a smooth horizontal position. The lines of force are thus permitted to arrange themselves under no other influence than that of the magnetic force existing in the armature and field.

Dissectible Features. Fig. 2 shows the three basic parts of the apparatus, — the armature with the commutator, the field magnet with base, and the brush-holder. The instrument is readily dissected, as the illustration shows. Each part may be studied separately, as will be noted from the following list of experiments.

We desire to call attention also to the fact that the field coil is easily removed from its base and the base so designed that 6-inch permanent magnets may be substituted for the field coil, thus teaching the fundamental principle of the magneto.

WHAT THE INSTRUMENT IS DESIGNED TO TEACH



No. 97-115 (Dissected) Fig. 2

Experiment 1. **Study of the field magnet** in an electromagnet, the lines of force being mapped out either by compass or filings method.

Experiment 2. **To show what effect the soft iron ring** of the armature has upon field magnets. The value of this exercise is greatly increased by using the filings method of mapping the field and comparing the field with results obtained above.

Experiment 3. A detailed **study of the armature,** showing that it is wound in sections and where the ends of each section are.

Experiment 4. A **detailed study of the commutator** by passing the current into the armature magnet through the brushes, showing by this method the exact position of each section when polarity is reversed.

Experiment 5. The method of **answering** definitely **why the armature of a motor rotates.** The action of the lines of force as indicated by the filings method will make this clear.

Experiment 6. A **study of the magneto generator,** its relation to the regular commercial dynamo, showing definitely why the current is generated when the armature is rotated between the poles of a magnet.

Experiment 7. A **study of the magneto and its relation to the dynamo,** also why the armature in a magneto machine rotates.

Experiment 8. A **study of the dynamo using electromagnetic field and armature.** Determining the relation of the armature to the field coils and the speed of the armature to the strength of the magnetic field.

Experiment 9. The **study of different types of dynamos and motors** depending upon whether the armature and field are connected in series or in multiple, and what are the conditions regulating the method of connecting in any given machine.

Experiment 10. To show what the result will be if the armature is removed and a permanent bar magnet be mounted on the same bearing. This experiment teaches clearly the reason **why the armature must be an electromagnet and not a permanent magnet.**

Gilley Gramme Machine **$7.75**

No. 97-125

MILLER-COWEN ATTACHMENT TO GILLEY GRAMME MACHINE

This attachment, designed by G. A. Cowen and F. R. Miller of the Boston High Schools, further increases the educational value of the Gilley Gramme Machine by applying the method of clear, open construction as used in that machine to the parts that are too often neglected but the operation of which is of the utmost importance. This attachment allows of the removal of the armature iron so that experiments may be conducted either with a simple revolving armature coil or with the enclosed iron core as desired.

In addition to a large commutator, collecting rings are provided for the proper investigation of the alternating type of motor and generator. A handle furnishes a ready means of revolving the armature.

No. 97-125 (Dismounted Field Magnet)

The use of this device in connection with our Universal Galvanometer No. **93-130** is recommended, as it is built to work in connection with an instrument of its range. This attachment is carefully constructed and most rigidly tested in our laboratory before shipment. Each instrument is guaranteed satisfactory, and its design will commend it as a valuable educational instrument.

Special Features. The large commutator for both A. C. and D. C., the ready means of changing brushes to make contacts with either A. C. or D. C. commutator without changing the galvanometer connections, the ease with which the field magnets may be removed and bar magnets substituted, the ready removal of the laminated core, are features which make it an educational instrument of the utmost value.

As a dynamo analysis machine of simplest form it has met with much favor in vocational schools.

No. 97-125 (Mounted Field Magnet)

97-125 MILLER-COWEN ATTACHMENT, including the **Field Magnet** **$10.50**

97-127 MILLER-COWEN ATTACHMENT, without the Field Magnet for those who already have No. **97-115** Gilley-Gramme Machine **8.00**

No. 97-148

DIRECT CONNECTED HAND POWER DYNAMO AND MOTOR

No. 97-148

This instrument is provided with coils, collecting rings and commutator so that it will work to highest efficiency in the production of either alternating or direct current. As ordinarily used on the lecture table the output may be roughly stated as 15 volts and 7 amperes. but a greater output can be obtained if desired.

Field and armature may be connected in series or shunt, making it possible to teach definitely, — **Direct Current Shunt Wound Dynamo, Self-Exciting Alternating Current Dynamo, Series Dynamo Motor, Rotary Converter or Motor Generator.**

SPECIAL FEATURES:

Dissectibility. Pole pieces separated and armature removed without the use of wrench or screw driver. Can be taken apart and reassembled on the lecture table while the lecture is in process.

Efficiency. Will easily generate 100 watts of electrical energy and is guaranteed to give 200 watts, — a new accomplishment in instruments for educational work.

Design. Careful study has been made of commercial types which we have modified only to the extent of obtaining the dissectible and educational features which we consider of prime importance.

Driving Mechanism. In eliminating the belt and substituting the enclosed oil-immersed, direct connected gear drive, a long step in advance has been made in the construction of Hand Power Dynamos. This feature had in part been worked out in our Hand Power Dynamo No. **97-150,** the success of which led us to take the next step and eliminate entirely the losses due to the belt drive. By careful estimate, this method of drive gives an increased efficiency of about 60 per cent.

Field Magnet. Two-pole type which allows the use of a large amount of iron and permits of a construction which makes the shortest magnetic circuit, at the same time allowing a clear view of the pole pieces and their relation to the armature.

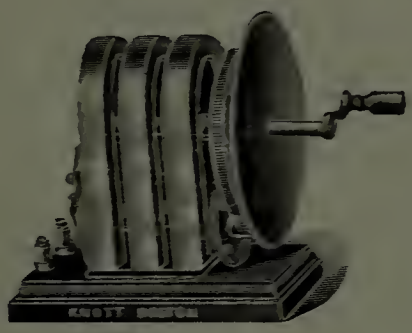
Field Coils. Wound on thin-spun metal bobbins, each core being designed for a definite purpose. depending upon whether the instrument is to be connected series or shunt wound, giving the greatest efficiency for each type.

Armature. Drum type, which has proven best suited for withstanding hard usage. The coil sections are wound in slots in the laminated iron core. The anchoring of the coil has been done in the most perfect workmanlike manner.

Commutator. Larger size proportionately than would be used on a regular commercial machine, for the reason that it is a part of the design of this instrument that all of the essential features be large enough so that the students can readily study their functions.

Collecting Rings. Placed on the same end of the shaft as the commutator, a design which simplifies the instrument. The attachment holding the brushes serves both for alternating and direct circuit, thus offering a ready method of comparison. Price **$40.00**

No. 97-160



No. 97-155

No. 97-165

97-165 MAGNETO. This instrument is a regular commercial dynamo of the permanent magnet type, employing magnets of unusual strength. A very efficient armature is provided with crank and gears so that it may be readily operated by hand. This instrument is frequently used in telephone exchanges and often as a testing instrument in locating broken circuits in coils. Its operation is similar to that which takes place in the Page Motor Apparatus below. Its educational value is in the practical and powerful effects that can be obtained by using permanent magnets. The earlier forms of power machines were built on this principle $5.65

97-160 PAGE MOTOR APPARATUS. This apparatus will be found of great value in teaching the basic principles of the electric motor and dynamo. By utilizing the horseshoe magnet, the student is not confounded with the unusual shape of pole pieces as met with in most motor or dynamo appliances. It will also be seen that the use of a permanent horseshoe magnet allows the armature and its commutator together with the brushes to be laid out on a flat surface so that each part can be seen whether as a unit or working together. If desired, the lines of force can be readily plotted in the usual method by iron filings. This instrument can be used either as a generator or a motor, as desired. By slowly moving the armature by hand, a clear understanding can be had of its operation.

The instrument is well made, employing a powerful magnet, so that it can be depended upon to give satisfactory results in the hands of students 3.50

97-165 PAGE MOTOR APPARATUS, ELECTROMAGNETIC FIELD. This apparatus is particularly designed to show in a clear and comprehensive manner the action of an electromagnet as used in the modern motors and dynamos. The field coils are mounted on a soft U-shaped frame corresponding in general appearance to the permanent magnet of the No. 97-160 Page Motor Apparatus above, thus permitting direct and clear comparisons of the magnetic fields. The armature provided with this outfit still further illustrates the action of the electric current, for the iron used in the motor apparatus above is entirely dispensed with, the rotation being brought about by the direct action of the electromagnet field on a solenoid. Commutators, binding posts and brushes for connecting in various series and shunt combinations, are placed so that they can be clearly inspected. The apparatus will operate as a motor on two cells of battery.

This apparatus is constructed accurately of the best obtainable material, and all parts are nicely fitted. It will be found a valuable instrument in the teaching of electro-dynamics. As a companion instrument with the Page Motor Apparatus No. 97-160, a direct comparison of permanent and electromagnetic types of instruments makes an interesting study 9.75

MOTORS

ALTERNATING AND DIRECT CURRENT

1/30 TO 1/4 H. P.

The well-known line of "Standard" Motors listed on this page is guaranteed to be mechanically and electrically perfect. The solidity of construction, the correctness of design coupled with the unsurpassed enameled finish, place them at once at the head of all motors. The material used is the best that can be obtained. They are of unusually high efficiency and are fully as durable as the larger size machines. They may be absolutely relied upon for years of satisfactory service.

Nos. 97–175 to 97–179

Nos. 97–181 to 97–183

DIRECT CURRENT COMPOUND WOUND MOTORS

Prices of series or shunt wound motors on application.

Number	H. P.	Speed	Prices 115 Volts	230
97–175	1/30	1150	$14.15	$15.50
97–177	1/20	1750	15.85	17.25
97–179	1/8	2000	18.00	19.80
97–181	1/10	1150	20.25	22.00
97–183	1/8	1750	21.75	23.25
97–185	1/8	1150	28.50	30.00
97–187	1/6	1750	31.00	34.50
97–189	1/4	2000	34.50	38.00

SINGLE PHASE INDUCTION MOTORS

Nos. 97–200 to 97–222

Full Load Start 60 Cycles Continuous Duty

Number	H. P.	Speed	Prices 115 Volts	230
97–200	1/30	1150	$17.50	$19.50
97–202	1/30	1750	16.00	18.00
97–204	1/20	1150	24.25	26.25
97–206	1/20	1750	21.00	23.00
97–208	1/10	1150	27.50	29.50
97–210	1/10	1750	23.75	25.75
97–212	1/8	1150	29.25	31.25
97–214	1/8	1750	28.75	30.75
97–216	1/6	1150	44.00	46.00
97–218	1/6	1750	40.00	42.00
97–220	1/4	1150	54.00	56.00
97–222	1/4	1750	51.00	53.00

97–250 CANVAS FRICTION BRAKE, after Fuller and Brownlee (Experiment 85) **$0.75**

GENERATORS

Nos. 97–270 to 97–272

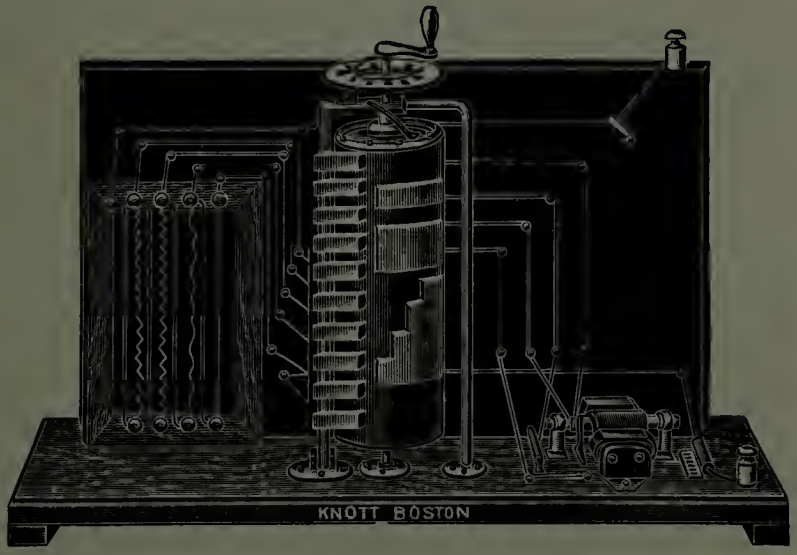
Nos. 97–274 to 97–278

The generators listed below are guaranteed to be of the very best material and workmanship, free from either electrical or mechanical defects, and will carry their rated load continuously without attaining a temperature greater than 40° Centigrade in excess of that of the surrounding air.

Prices are for compound wound generators and include standard pulley, sliding base with belt-tightening attachment and wall type field regulating rheostat.

The speed stamped on the name plate of each dynamo is that at which it should be driven when it is desired to operate it at the voltage marked.

Number	K. W.	Number of 25 Watt 16 C. P. Lamps	Speed 115 and 230 Volts	Size Pulley Diam.	Size Pulley Face	Price 115 V.	Price 230 V.
97–270	½	20	1850	4	2	**$48.00**	**$51.00**
97–272	¾	30	1750	4	2½	**62.50**	**65.00**
97–274	1	40	1650	5	2½	**80.00**	**84.00**
97–276	1½	60	1550	5	3	**88.50**	**93.00**
97–278	2	80	1400	5½	3½	**110.00**	**115.00**



No. 97–285

97–285 CONTROLLER MODEL. The above illustrated device is designed to illustrate in a practical manner the method of controlling the speed and operation of the modern electric railroad motor. The commutator, resistances, etc., are well worked out in open construction so that the various changes that occur and their effects upon the included model motor may be noted with ease and accuracy.

The construction is substantial, parts clearly shown, and the whole design well suited for its didactic purpose.

Complete as illustrated with motor **$31.00**

ELECTRO-DYNAMIC CHARTS

No. 97-300

97-300 ELECTRO-DYNAMIC CHARTS for demonstrating the principles of dynamos and motors. These charts, which are finely lithographed in colors and mounted on heavy cardboard, are of ample size, 28 × 30 inches. They may be seen across the largest lecture hall; the complex mechanism of the dynamo and motor, both alternating and direct current, may be clearly shown. The different windings, connections, armatures, poles, etc., are greatly magnified that they may be readily seen. Each chart is mounted in a frame and the armature is rotated by means of a crank operated from the rear. That the change of polarity may be demonstrated, change of poles in the armature is automatically shown by different colors, one color for the North pole and another for the South pole.

The set consists of charts as follows: —

Group I. Double Chart consisting of: —

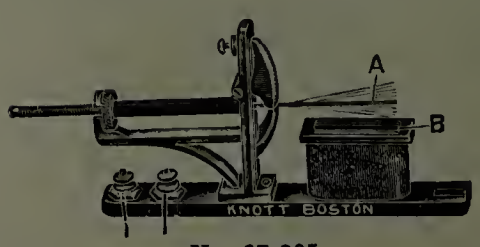
a. 1 Attachable hinged disc for the dynamo.
b. 1 Attachable hinged disc for the motor.
c. 2 Discs for Gramme's Ring.
d. 1 Colored disc for the magnetic field.
e. 1 Double Collector, one side with two collecting rings, the other with an eight-segment commutator.
f. 2 Brushes.
g. 4 Connecting Cords.

With the above Group the following demonstrations can be readily performed: —

1. Magneto Electric Machine, 2-pole armature, alternating current.
2. Magneto Electric Machine, 2-pole armature, direct current.
3. Two-pole Dynamo.
4. Dynamo with Gramme's Ring Armature.
5. Alternating Current Motor, 2-pole.
6. Motor with Gramme's Ring Armature.

Accessory Chart II for use in demonstrating alternating current machines.
Accessory Chart III for demonstrating alternating current motor.

Complete as above listed . . . . . Duty Free . . .



No. 97-305

97-305 PROJECTION FREQUENCY INDICATOR for 110 A. C. Volt Current. This instrument is designed primarily to show on the screen the effect produced by an alternating current on an electromagnet. The length of the vibrating reed is such as to show clearly on the screen, the one-quarter wave length, the one-half wave length, and the three-quarter wave length. In use the instrument is connected directly to 110 volt alternating current without additional resistance **$7.50**

ALTERNATING CURRENT DEMONSTRATION APPARATUS

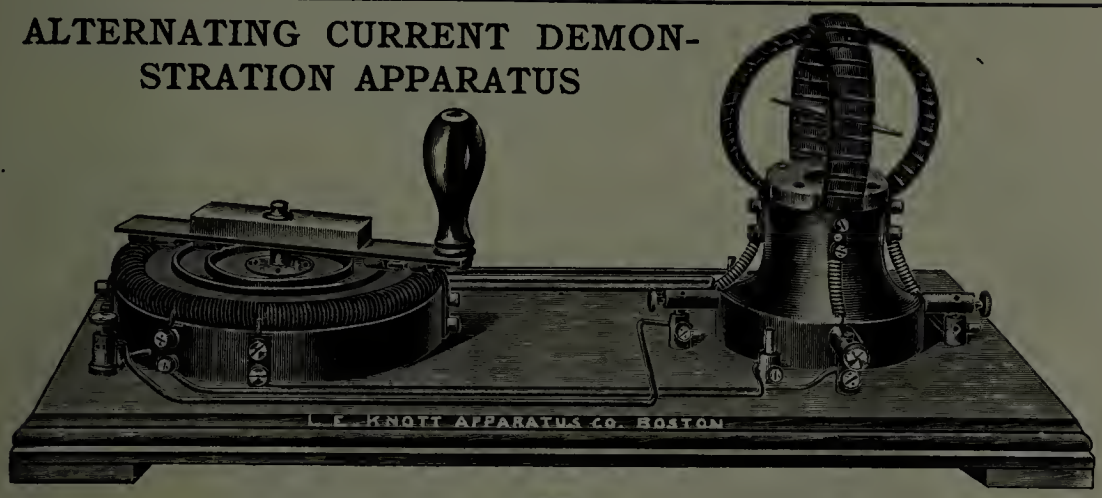


Fig. 1

Fig. 2

Fig. 4

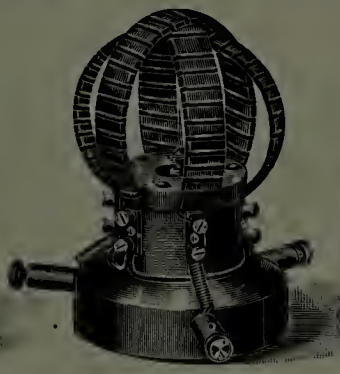


Fig. 3

Fig. 5

No. 97-310

97-310 WEINHOLD'S ROTARY FIELD APPARATUS for the study of the essential principles of an induction or alternating current motor for either two-phase or three-phase currents, demonstrating clearly the rotating magnetic fields.

The complete apparatus consists of a substantial base on which are mounted the current distributing apparatus, Figure 1, connecting wires, and necessary devices for the interchangeable parts, the one illustrated on the base board being a double coil. In addition there are furnished accessory coils as follows: Ferraris' Double Coil, Figure 2; Ferraris' Triple Coil, Figure 3; 4-coil Iron Ring, Figure 4; Ring of 6 Coils, Figure 5; Magnetized Needle and Iron-plate Disc with agate socket, closed circuit armature; and perforated glass plate with alcoholized iron filings.

This apparatus permits of experiments demonstrating in a practical manner the effect of the rotary field. In use from 4 to 6 cells of battery are required. This current can be changed into an alternating current or rotary current by the distributing apparatus. This current is made to pass through the twofold or three-fold crossed coils of wire of various colors. In the middle of either of these coils may be placed a magnetic needle or an iron disc. By the rotation of the distributing apparatus there is produced a current of either two or three phases, according as the twofold or threefold ring is used, and the bodies placed within the coils rotate under the influence of the rotary field. Instead of these wire armatures, however, an iron ring of 4 or 6 coils may also be used. Such rings, Figures 1 and 3, are wound with wire wrapped with a covering of different colors. By means of such rings synchronous rotation may be produced by the insertion of a magnetic needle or an iron disc; and by an iron ring wound with copper wire (closed circuit armature) non-synchronous rotation can be produced.

No. 97-315

The lines marking the direction of the influence of the rotary field can also be more strikingly shown by means of a glass disc covered with the iron filings furnished with the apparatus.

This instrument is of substantial structure, all parts neatly and handsomely finished, especially designed for teaching the principles involved. The rotating parts are mounted with agate caps and steel-bearing points. All wiring is indicated by different colors. All connections are open to view on top of the base. The base is of highly polished hardwood.

Complete with full directions for use $40.00

97-315 THREE-PHASE CURRENT MOTOR MODEL (Tesla Motor) for use with above Weinhold's Rotary Demonstration Apparatus, for the study of a rotary current motor.

This model is furnished with six fields, closed circuit armature, with three leads. The winding is made in three colors and the connections are open and in colors. The apparatus is practical, clearly arranged, and shows the experiments in all their bearings. It is highly recommended as an additional accessory to the above outfit 19.50

TELEGRAPHY AND TELEPHONY

TELEGRAPH INSTRUMENTS

No. 98–10

No. 98–15

No. 98–20

No. 98–25

98–10 **TELEGRAPH KEY,** nickel-plated lever, brass frame, gutta-percha knobs, improved adjustment spring holders, all parts finely finished, without legs **$1.90**

98–12 **TELEGRAPH KEY PARTS,** after Turner and Hersey (Experiment **E100**) . . . . . Set **1.00**

98–15 **IMPROVED SOUNDER,** unequaled for quick action, loudness, and clear tone, proportioned scientifically correct, brass lever, resistance 5 ohms **2.50**

98–17 **TELEGRAPH SOUNDER PARTS,** after Turner and Hersey (Experiment **E100**) . . . . . Set **1.00**

98–20 **TELEGRAPH RELAY,** excellent quality, finely finished and mounted on polished mahogany base with ornamented metallic sub-base. Standard resistance of 5 ohms **3.40**

98–25 **COMBINATION KEY AND SOUNDER.** This instrument is designed to fulfil the requirements of a short-line apparatus. The sounder magnets, lever, anvil, and key lever are the same as used on the preceding instruments. The frames for holding the sounder lever and key lever are stamped from wrought iron and heavily japanned. The base is constructed of polished mahogany. This instrument will give entire satisfaction on lines up to five miles in length. Resistance 5 ohms . . **2.50**

TELEPHONE INSTRUMENTS

No. 98–100

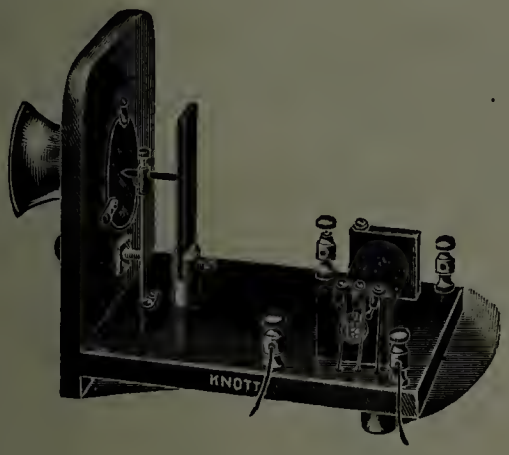
No. 98–105

No. 98–110

98–100 **DEMONSTRATION POSTLESS BI-POLAR RECEIVER.** As may be noted from the illustration, this instrument is entirely dissectible, and in consequence has a value as a demonstration instrument, as well as that of a working receiver. All parts are carefully fitted and finished and the receiver is high grade in every respect **$1.45**

98–105 **SOLID BACK WATCH CASE RECEIVER,** 2¼ inches diameter, weight 6 ounces, resistance 75 ohms, rigid adjustment. This is a simple receiver sufficiently sensitive for practically all laboratory work **1.00**

98–110 **SOLID BACK LONG-DISTANCE TRANSMITTER.** This transmitter is the standard commercial type furnished on long-distance telephones. They articulate distinctly and plainly with no up and down variations or sizzling **2.00**



No. 98–125

No. 98–135

98–125 TELEPHONIC MICROPHONE. This instrument illustrates in a clear and comprehensive manner not only the microphone but the adaptation of same in the articulating telephone. It is in reality two instruments in one, requiring only the simple adjustment of a thumb screw to change it from a simple contact telephone to a practical working telephone. The small induction coil on the base shows the manner of raising the potential of the telephonic circuit, which is inductively connected. The results attending the connecting of the instrument with an ordinary telephone receiver and battery cell are surprising. The ticking of a watch or the fall of a feather is heard with remarkable distinctness **$5.75**

98–135 KNOTT BATTERY CALL TELEPHONE. This is a handsome, well-constructed instrument with solid back transmitter, double pole receiver, vibrating bell and call button. Guaranteed to give full satisfaction on all short lines. Readily set up from full directions which accompany the instrument . . . . . Each **4.25**
Per pair **8.50**

SELENIUM CELLS

No. 98–141

No. 98–142

98–140 SELENIUM CELL. The scientific importance of the Selenium Cell has been recognized since the work of Bell and Ruhmer. It was not, however, until recently that its possibilities in the commercial field were fully realized. Many experimenters now agree that it is through the medium of the Selenium Cell that the "seeing" telephone may eventually become a reality. In our work with Selenium we have discovered a most satisfactory method of attaching the material to the metal backing and improved methods of annealing are employed. The object has been to obtain a permanent surface and large area for the light to act upon and an area which will give as low initial electrical resistance as possible.

This Selenium Cell is extremely sensitive to light, dropping in resistance many thousands of ohms when illuminated by a light of average intensity. Connected in series with a relay and battery, it will cause the relay circuit to be closed when the cell is illuminated. If a screen be interposed between the light and the cell, the relay circuit will be immediately opened. A telephone receiver connected in series with the Selenium Cell and a suitable battery will cause fluctuations in light to be detected. For example, the alternating current arc gives a tone depending upon the frequency of the current. Changes in the intensity of a direct current arc produced by superimposing on it a telephone current are audible.

Selenium Cell unmounted, surface 7 mm. square **$5.00**

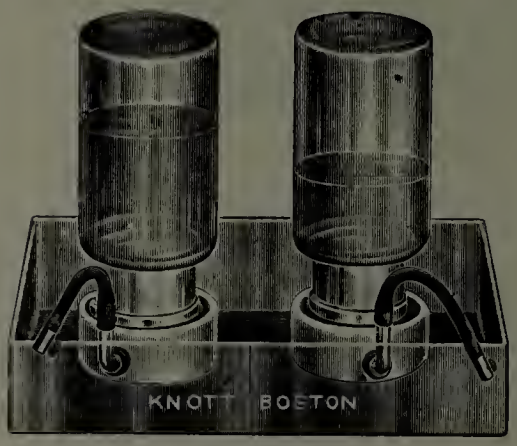
98–141 SELENIUM CELL, same as above, but with rectangular selenium surface. 44 × 19 mm. **11.50**

98–142 MOUNTED SELENIUM CELL. Consists of Selenium Cell No. **98–141** above with Adjustable Support No. **98–145** **14.00**

98–145 UNIVERSALLY ADJUSTABLE SUPPORT, especially designed for holding the mounted Selenium Cell **2.50**

MISCELLANEOUS APPLICATIONS OF ELECTRICITY

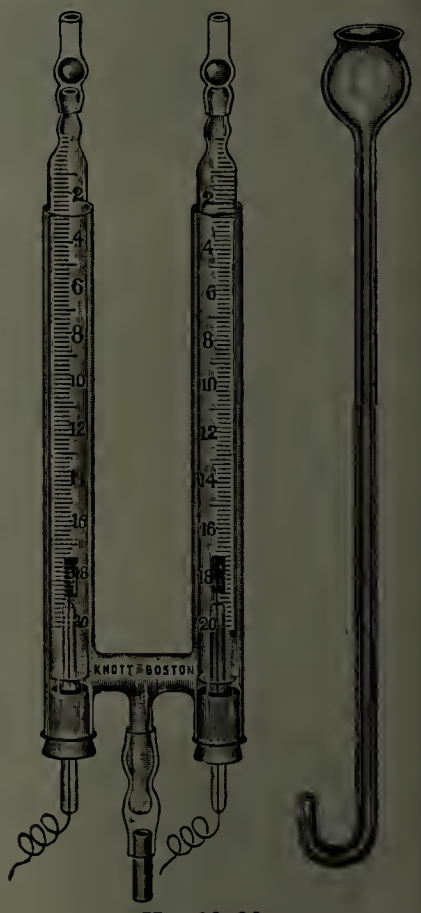
ELECTROLYSIS AND ELECTRO-CHEMISTRY



No. 99–5

No. 99–10

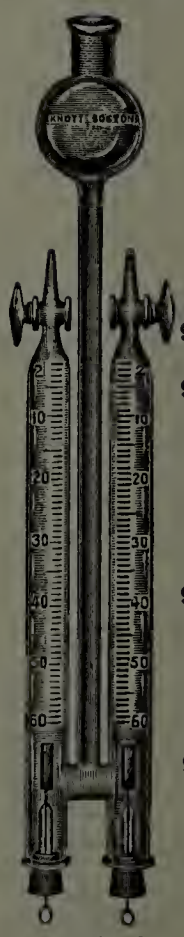
No. 99–15



No. 99–30

99–5 PACKARD'S ELECTROLYSIS APPARATUS. We are indebted to Mr. John C. Packard of Brookline High School for this design. In simplicity of operation and cleanliness, it excels other apparatus designed for the same purpose. There are no parts which, when broken, cannot readily be replaced. Consists of two special moulded porcelain bottle rests which are designed as electrode supports. These bottle and electrode supports can be used close together or apart to the limit of the glass tray. In use, the bottles and tray are filled to a point covering the mouths, with the electrolyte. When current is connected, action immediately begins.

Complete as illustrated with glass tray . . . **$2.60**



No. 99–20

99–10 SIMPLE ELECTROLYSIS APPARATUS. This is the standard form with sliding graduated tubes and platinum electrodes **$2.50**

99–15 THE H-ELECTROLYSIS OF WATER APPARATUS. This is an improved type of electrolysis apparatus so designed that the platinum electrodes may easily be replaced by those of carbon or copper. In addition the reservoir tube is directly connected without bend to the junction tube of the gas tubes.

This type is ungraduated, and is for use with rubber tubing and pinch-cocks.

Complete with platinum electrodes **2.60**

99–20 THE HOFFMAN'S H-FORM ELECTROLYSIS OF WATER APPARATUS. This design has the same improvements as the one above. It, however, has graduated gas tubes provided with glass stop-cocks and the reservoir is globular shaped.

Complete with platinum electrodes **7.50**

99–30 OSBORNE'S IMPROVED ELECTROLYSIS APPARATUS. This design has the merit of efficient use in study of principles involved in electrolytic dissociations. It consists of an H-tube with graduated slide tubes, each with shot valve. By the improved construction of detachable electrodes the platinum electrodes may be readily replaced by those of carbon or copper as illustrated. With a glass stopper plug the apparatus is set up as a conductivity cell. In use for study of electrolysis of water the stopper plug is replaced by the bent end of the thistle tube.

Complete as illustrated **4.80**

99–50 **CARBON ELECTRODES,** as used in Nos. **99–15** and **99–30** **$0.55**

99–52 ——, for No. **99–20** . . . . . **.75**

99–55 **COPPER ELECTRODES,** as used in Nos. **99–15** and **99–30** . . . . . **.55**

99–57 ——, for No. **99–20** . . . . . **.75**

99–60 **PLATINUM ELECTRODES,** as used in Nos. **99–15** and **99–30** **1.50**

99–62 ——, for No. **99–20** **3.00**

99–75 **TUBE SUPPORT.** It is always advisable and oftentimes necessary to support an Electrolysis of Water Apparatus during experimentation. Our support consists of a neat stand with clamp and binding posts **1.65**

99–80 ——, same as above, but smaller in size **1.40**

No. 99–100

No. 99–105

No. 99–195

99–100 **LANTERN ELECTROLYSIS DEMONSTRATION APPARATUS.** This design consists of a U-shaped trough provided with a hard rubber cover with binding posts to which are connected the platinum electrodes. This form will not leak and is not constructed with cumbersome compressor clamps.
It is a neatly and handsomely finished scientific piece of apparatus **$4.75**

99–105 **HYDROGEN ABSORPTION APPARATUS,** after Hall's "Elements of Physics," Paragraph 50, for showing the power of palladium to absorb hydrogen. Consists of a palladium and a platinum wire mounted parallel in a solid vulcanite frame. Binding posts supplied for connecting to a source of electric current.
The frame is placed upright in a two per cent. solution of sulphuric acid and then an electric current, strong enough to decompose the solution, is connected to the binding posts. It will be noted that there is a visible flow of oxygen bubbles from the platinum wire, but no hydrogen bubbles from the palladium wire. Palladium, when cold, absorbs several hundred times its own bulk of hydrogen. Without beaker **4.25**

MATERIAL FOR ELECTROPLATING

99–110 **SILVER ANODE,** sheet form **1.25**

99–115 **NICKEL ANODE,** sheet form . . . . . **.75**

99–120 **COPPER ANODE,** sheet form . . . . . **.50**
COPPER SULPHATE, 1 pound bottle . . . . . **.20**
AMMONIA HYDROXIDE, 1 pound bottle . . . . . **.30**
AMMONIA HYDROXIDE, 4 pound bottle **1.00**
POTASSIUM CYANIDE, 1 pound bottle . . . . . **.50**
NICKEL AND AMMONIUM SULPHATE, 1 pound bottle . . . . . **.50**
SILVER CHLORIDE, 1 ounce bottle . . . . . **.90**
POWDERED PUMICE, 1 pound package . . . . . **.15**
ROUGE, 1 pound package . . . . . **.40**
TRIPOLI, 1 pound package . . . . . **.15**
POWDERED EMERY, 1 pound package . . . . . **.15**

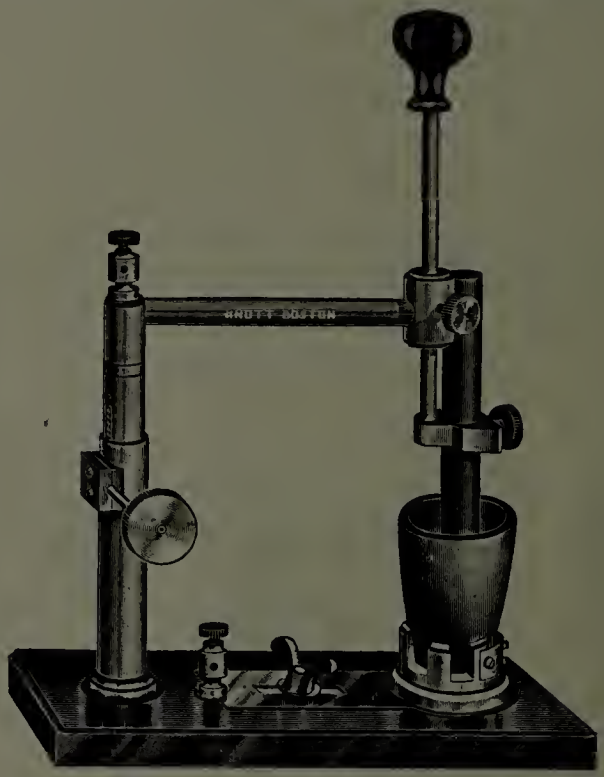
99–125 **ROUGE CLOTH,** especially prepared . . . . . **.20**

99–130 **CHAMOIS SKIN** . . . . . **.65**

We shall be very glad to supply the formulæ on request for making solutions for silver, nickel, or copper electroplating.

99–170 **ELECTROTYPING LETTERS,** after Turner and Hersey (Experiment **E163**); also used in Fuller and Brownlee (Experiment **71**).
Set of three letters **$0.15**

99–195 **ELECTROPLATING OUTFIT FOR COPPER PLATING,** consisting of jar, special clamp castings, insulating support for same, two copper electrodes, chemicals and complete directions for copper plating **1.65**

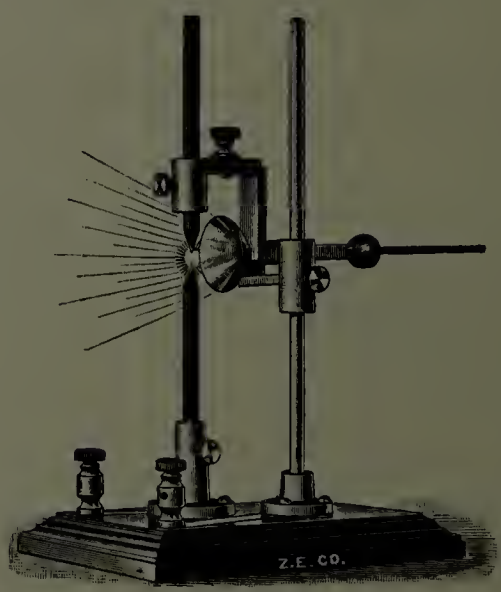


No. 99–200

99–200 SIMPLE ELECTRIC FURNACE. A simple practical form of electric furnace that will be found of great utility in the teaching of the electric arc, electric furnace, as well as the melting and combining properties of many elements. The construction enables a clear understanding of the many principles involved. Its open construction has great pedagogic value.

A great variety of experiments may be conveniently performed, — the melting of platinum or like refractory metals, the reduction or production of aluminum or carbides. The manufacture of calcium carbide from lime and sawdust or carbon makes a striking and interesting experiment.

Complete ready for use **$26.00**



No. 99–350

99–350 DEMONSTRATION ARC LAMP WITH REFLECTOR for use with any strong source of battery current, but excellent for use with our No. **97–148** Gear Drive Hand Power Dynamo in demonstrating the principle of arc lamps. It is a near approach to the automatic form, adjustment by counterpoise gravity feed. Quite simple in form and of open construction throughout. A simple reflector attached adds greatly to the effectiveness of the design. Complete as illustrated . . . **$3.30**

TOOLS

We list below various tools which will be found of service in the laboratory.

200–10 **AUGUR BITS,** set of thirteen, from ¼ to 1 inch $4.75

200–15 **BIT BRACE** 90

200–20 **BLOCK PLANE** of iron, 5½ inches long 45

200–22 **BREAST DRILL.** Chuck has three drawers which hold round shanked bits from 0 to ½ inch. Drive wheel 5 inches diameter. Gearing changeable three to one. Crank adjustable permitting variation in length of 3½ inches. A first-grade tool throughout 3.80

200–25 **CHISEL,** best Sheffield steel, one inch wide 50

200–30 **CLAW HAMMER,** first quality of cast steel, weight one pound 60

200–35 **CLAW HAMMER,** nickel-plated, ordinary grade 48

200–40 **COLD CHISEL,** ½ inch 20

200–45 **CORK SCREW,** large size 15

200–50 **FILE,** flat, 8 inches long 20

200–55 **FILE,** half round, 8 inches long 20

200–60 **FILE,** round, 8 inches long 18

200–62 **FILE,** triangular, 8 inches long 18

200–65 **GIMLET,** large size, 5 inches long 15

200–70 **HACK SAW,** consisting of malleable steel frame and saw blade 55

200–75 **HACK SAW BLADES,** 8 inch, to fit the above frame . . . . . Per Dozen .60

200–77 **HATCHET, STEEL CLAW, best forged steel,** highly polished blade, bronze finish 75

200–78 **NIPPER,** end cutting, length 6 inches 50

200–80 **OIL STONE,** in wooden box, 7 inches long 35

200–82 **PITCH GAUGE, "V"** threads, 22 pitches, — 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72 and 74 threads per inch 1.25

200–85 **PLIERS,** with side cutting blade, 5 inches 50

200–86 **PLIERS, COMBINATION SLIP JOINT, best forged steel,** natural finish, polished jaws, length 6½ inches . . . . . Each .40

200–88 **PUNCH, SPRING, cast steel,** first quality, full polished 35

200–90 **SAW, CROSS-CUT,** 26 inches long 1.50

200–95 **SAW, RIP,** 26 inches long 1.65

200–100 **SAW, KEY-HOLE** 25

200–105 **SCREW DRIVER,** instrument size, with small sharp blade 20

200–110 **SCREW DRIVER,** heavy, 8 inch 25

200–115 **SHEARS,** metal cutting, 2½ inch blade 75

200–116 **TAP AND DIE SET.** Complete with stock round tap wrench, seven adjustable dies and seven taps cutting the standard threads used in the manufacture of our apparatus: — 2/56, 4/32, 6/32, 8/32, 10/32, 12/24 and 14/24. In polished hardwood case 7.50

200–117 **TOOL CABINET for wall.** Contains 18-inch panel saw, smoothing plane, half hatchet, nail hammer, bit brace, ⅜ and ½-inch bits, 5-inch butt chisel, scraper, awl and tool set, 6-inch flat-nose plier, 2/32-inch nail set, 6-inch try square, folding boxwood rule, marking gauge, 4/36-inch gimlet bit, 8-inch mill file with handle, oil stone, carpenter's pencil, oil can, can of glue, 2 sheets of sandpaper, spool of wire, assorted screws, nails, brads and tacks. All tools of the highest grade of steel. Solid oak cabinet 24 × 16 × 6 inches deep, doors panelled, antique finish, varnished and hand rubbed, with brass padlock with two keys 21.00

200–118 **TOOL HOLDER,** hollow polished cocobolo handle, containing the following tools warranted the highest grade of steel: — two sizes firmer chisels, gouge, three sizes of screw drivers, gimlet, key-hole saw, scriber, reamer, finely finished throughout 1.10

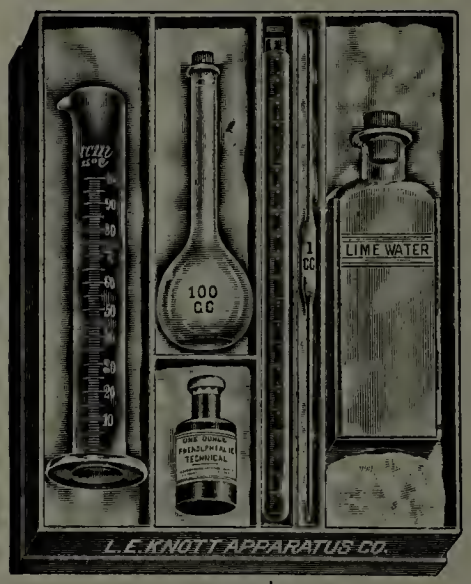
200–119 ——, similar to above but smaller and containing ten tools, as commonly supplied 40

200–120 **WRENCH (MONKEY WRENCH),** 8 inches long 60

FIRST AID CABINET

No. 200–150

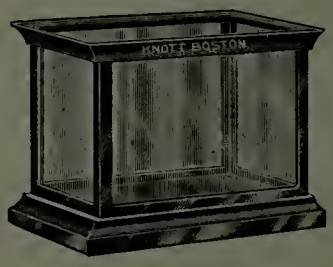
Every science laboratory should be equipped to render first aid in treating cuts and burns. That we may adequately meet this need, we have made up a first aid cabinet containing both gauze and cotton bandages, styptic and surgical gauze, court plaster, pins and the ordinary condiments required to stop bleeding and for the proper treatment of burns, as well as for first aid treatment in case of poisoning. Cabinet filled complete $2.50



No. 3500

No. 3502

No. 3522



No. 3525

No. 3520

3500 **AIR TESTER, DEWING'S,** for testing the amount of CO_2 in the air, according to National Biology Note-book Sheet **P51.** Complete with Lime Water, Phenolphthalein, Pipette, Graduated Flask, Graduated Cylinder, Graduated Tube and Plunger, with full directions **$3.50**

3502 **AIR TESTER,** after Dr. G. W. Fitz, for the accurate determination of CO_2.
Consists of a carefully graduated instrument, set of Storage Vials, Graduated Flask, Graduated Pipette and full set of directions. A most satisfactory piece of apparatus for an accurate determination of the amount of CO_2 in a room. With reagents in neat board case **3.00**

3504A **PHENOLPHTHALEIN SOLUTION.** Quantity sufficient for 100 tests . . . . . **.40**

3504B **LIME WATER.** Quantity sufficient for 100 tests . . . . . **.30**

3504C **GRADUATED FLASK,** 100 cc., for above apparatus . . . . . **.40**

3504D **GRADUATED PIPETTE,** 1 cc., for above apparatus . . . . . **.10**

3504E **GRADUATED PIPETTE,** 10 cc., for above apparatus . . . . . **.20**

ALCOHOLOMETERS. See Nos. **5673A** and **5673B,** page **448.**

3505 **SOLID ALCOHOL** for use in the can as an alcohol stove. This alcohol is a patented product moulded in solid form in a slip cover can. Always ready for instant use by removing cover and lighting contents of can. An intense heat is at once generated and can and contents can be used to as good advantage as an alcohol lamp. Flame readily extinguished by replacing cover upside down on top of can. Capacity of can 3½ ounces. Will burn continuously from one to one and one-half hours **.10**

3510 **ALUNDUM,** 60 mesh, for protecting the bottoms of Alundum Combustion Boats from the slagging effect of the iron oxide during the combustion of the sample . . . . . .Per ½-lb. Bottle **.50**

3512 **ALUNDUM CEMENT,** superior to other mixtures for covering wire resistors in many kinds of high temperature electrical apparatus and appliances . . . . . Per 2-lb. Bag **.70**

3515 **APRON,** chemical and water-proof, 48 inches long, 36 inches wide, readily adjusted to both sexes . . **.80**

OVERSLEEVES. See page **471.**

3520 **AQUARIA JARS, ROUND,** heavy colorless glass.

	a	b	c
Capacity, quarts	2	4	8
Size, inches	6 × 6	7 × 7	9 × 9
Each	**$0.80**	**1.10**	**1.65**

3522 **AQUARIUM JAR, RECTANGULAR,** heavy colorless glass, capacity 2½ gallons, 10½ inches long, 6½ inches wide, 10½ inches high **$4.00**

3525 **AQUARIA, enameled metal frames,** glass bottoms, finished in dark olive green with gilt decorations.

	a	b	c	d
Length, inches	12	15	18	21
Width, inches	8	10	12	14
Height, inches	7	9	11	13
Capacity, gallons	2½	5	7	12
Each	**$4.00**	**5.00**	**7.00**	**8.00**

3527 **AQUARIUM TANK, with iron frame work and stone base.** This aquarium must not be confused with those where the light is blocked from the ends by stone slabs. Our tank has **heavy plate glass in all four sides,** these glass plates being held by substantial iron frames locked at the corners by iron castings.
The base is of alberene stone 1¼ inches thick. In sealing the plates water-tight, we use a cement which we compound in our laboratories and which we guarantee will not leak nor soften by action of water.
Alberene stone base measures 32½ × 21 ins. Dimensions of tank, outside, 30½ × 19 × 16½ ins. deep.
Complete with standing overflow and brass gauze separating partition **$48.00**

3528 **SUPPORTING AQUARIUM TABLE.** We have frequently supplied a table support for the above aquarium. This table is built of solid oak with acid proofed built-up maple top. It is equipped with one drawer and further provided with a special long goose-neck water supply faucet.
F. O. B. Factory **26.00**

No. 6875

Nos. 42–152, 42–162, and 42–177

Nos. 42–150 and 42–160

No. 42–175

Nos. 42–153, 42–163, and 42–178

No. 42–190

No. 3550

6875 **ARSENIC TUBES,** hard glass.

	a	b	c	d
Each	$0.06	.06	.06	.06
Set of four				$0.22

ASBESTOS

Asbestos is fire and acid-proof and is, therefore, particularly adapted for use in science laboratories.

3540 **ASBESTOS BOARD,** 40 × 40 inches.

	a	b	c	d
Thickness, inch	1/32	1/16	3/32	3/16
Per Sheet	$0.42	.81	1.20	2.20

3541 **ASBESTOS BOARDS,** 3/32 inch thick.

	a	b	c
Size, inches	4 × 4	6 × 6	12 × 12
Each	$0.03	.04	.16

3543 **ASBESTOS BOARDS,** 1/32 inch thick.

	a	b
Size, inches	4 × 4	6 × 6
Each	$0.02	.03

3545 **ASBESTOS WOOL,** long selected fibre. Per 4-ounce package $1.10

42–150 **ASPIRATOR, CHAPMAN'S,** of brass, 3¾ inches long, ⅛ inch I. P. size thread, capacity 5 cubic feet per hour 1.45

42–152 **HYDRANT COUPLING** for attaching above aspirator to a ¾ inch hose bib or faucet 30

42–153 **HYDRANT COUPLING** for attaching above aspirator to a smooth faucet. This coupling cannot leak or be forced off 50

42–160 **ASPIRATOR, CHAPMAN'S,** of brass, 4¾ inches long, ¼-inch I. P. size thread, capacity 18 cubic feet per hour 1.95

42–162 **HYDRANT COUPLING** for attaching above aspirator to a ¾-inch hose bib or faucet 30

42–163 **HYDRANT COUPLING** for attaching above aspirator to a smooth faucet. This coupling cannot leak or be forced off 50

42–190 **ASPIRATOR, MUENCKE'S,** of glass, 8½ inches long. This is a convenient demonstration instrument as all parts are of glass 1.00

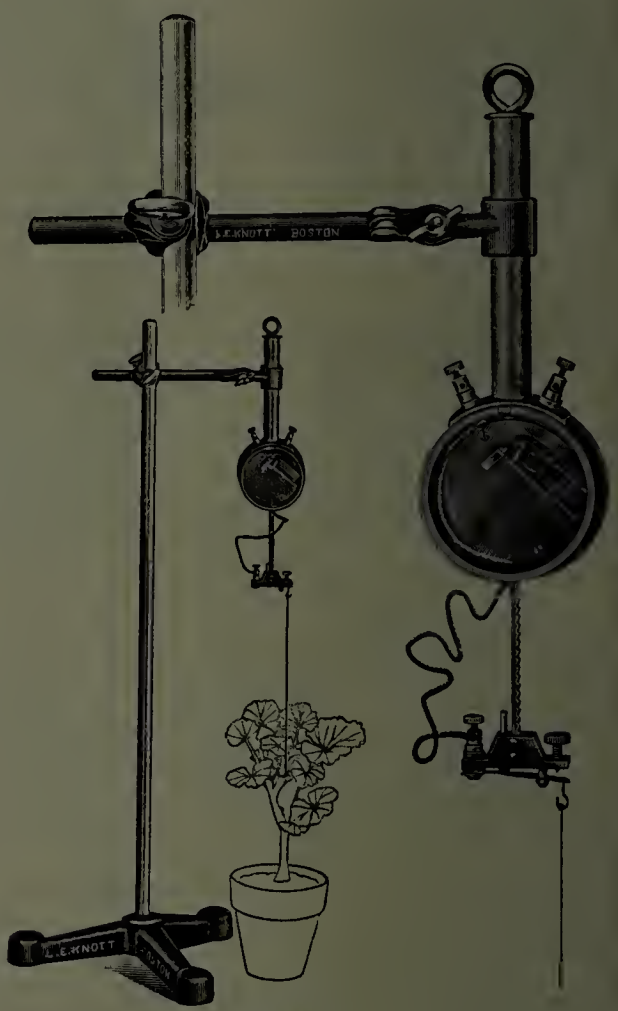
42–175 **ASPIRATOR, RICHARDS',** of brass, very powerful, 7 inches long, ⅜-inch I. P. size thread 1.80

42–177 **HYDRANT COUPLING** for attaching above aspirator to a ¾-inch hose bib or faucet 30

42–178 **HYDRANT COUPLING** for attaching above aspirator to a smooth faucet. This coupling will not leak and cannot be forced off 50

3550 **ASPIRATOR, HIGH VACUUM,** more powerful than preceding and uses less water, ¼-inch I. P. size thread. Length, 4¾ inches 1.65

No. 3560



No. 3563

3560 HARCOURT STUDENTS' AUXANOMETER. This instrument is not intended for precision work, but will be found most satisfactory in measuring the growth of plants with a reasonable degree of accuracy and sensibility. The apparatus as shown in the illustration is used on the regulation support stand and plant growth is indicated by movement of a pointer over a graduated arc. Without Support Stand **$3.25**

3563 BOVIE PRECISION AUXANOMETER, an invention by Dr. W. T. Bovie of Harvard University, for recording the growth of plants. For classroom or out-of-door use. Will indicate growth by as small as 0.1 millimeter.

The Bovie Precision Auxanometer consists essentially of a device which is carried upward as the plant grows.

When the device has moved a certain distance, it closes an electric circuit which operates the recording pen of the chronograph. This arrangement makes it possible to have the recording mechanism at any desired distance from the plant and to make simultaneous records of a number of plants or of various parts of the same plant.

The instrument is light, compact and quickly set up for use and, as the force of gravity is not utilized for moving any of its parts, it may be set at any angle with the vertical so that growth in any direction may be measured and recorded. Records of each 0.1 mm. of growth can be made and the instrument will be found reliable in or out-of-doors. The experimental model was run by Prof. Bovie the entire summer in the garden exposed to the weather, the brass case being open part of the time so that the internal mechanism was exposed.

Complete specifications furnished upon request.

Furnished in plush-lined polished hardwood box with hinged cover **25.00**

BALANCES AND WEIGHTS. See pages **45** to **63**.

No. 3570

No. 3572

No. 3579

No. 3580

No. 3575

No. 3577

3570 BATHS, SAND, DEEP HEMISPHERICAL, of sheet iron.

	a	b	c	d
Diameter, inches	3	4	6	8
Each	**$0.10**	**.14**	**.27**	**.45**

3572 BATHS, SAND, SHALLOW, of sheet iron.

	a	b	c	d
Diameter, inches	3	4	6	8
Each	**$0.08**	**.10**	**.18**	**.35**

3575 BATH, SAND or HOT PLATE. Measures 6 × 8 inches.
On legs **$1.70**

3577 BATH, SAND or HOT PLATE, RUEDORFF'S with ATTACHED BURNER. Of cast iron. Measures 11 × 7½ inches, with three rows of burners that are adjustable in height **14.25**

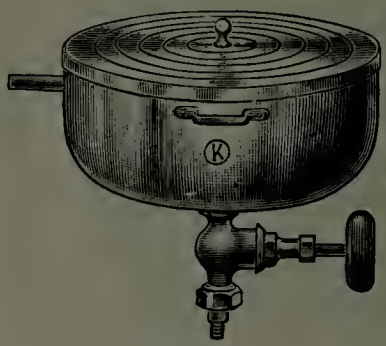
3579 PARAFFINE BATH, POLISHED COPPER, with tubulations for thermometer, gas regulator and three test tubes. Dimensions, 7 inches long, 3¾ inches wide and 3½ inches deep. With extra sheet iron bottom and iron base which is 5 inches high. Provided with a space for heating slides and two nickel-plated cups. The shallow cup is 2⅛ inches diameter, ¾-inch deep, watch glass shape, and the deep one is 2½ inches diameter and 1½ inches deep **9.75**

3580 PARAFFINE BATH, LEWIS', POLISHED COPPER. Temperature of this bath is maintained by a constant convectional current. The heated water enters the bath through the heating tube, leading from the heating cylinder into the side of the bath and the return pipe from the bottom of the bath conveys the cooler water back to the heating cylinder. The stopcock serves, also, to regulate the amount of hot water, thus regulating the temperature. Three deep cups, 1⅞ inches diameter by 1½ inches deep, two shallow cups, 1⅞ inches diameter by ¾-inch deep, four test tube or vial receptacles and one opening for the thermometer are provided **19.75**

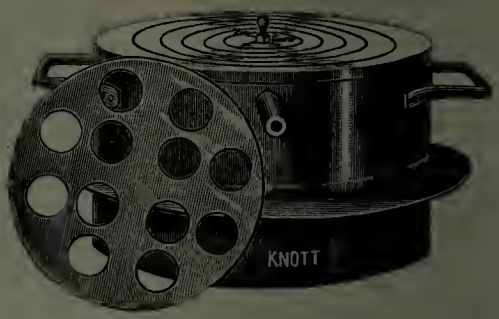
WATER BATHS

The water baths listed below are of polished copper, tin-lined, most carefully made throughout.

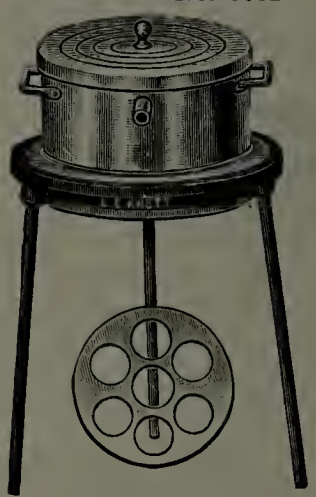
No. 3582



No. 3583



No. 3587



No. 3585

No. 3590

No. 3593

3582 WATER BATHS, POLISHED COPPER, tin-lined, with concentric rings and steam cover.

	a	b	c	d
Diameter, inches	5	6	8	10
No. of Rings	4	5	7	8
Each	**$1.30**	**1.70**	**2.70**	**5.30**

3583 WATER BATHS WITH STEAM VALVE, POLISHED COPPER, tin-lined, most excellent and economical.

	a	b	c
Diameter, inches	6	8	10
No. of Rings	5	7	8
Each	**$4.90**	**5.85**	**8.25**

3585 WATER BATH, POLISHED COPPER, ON TRIPOD, tin-lined. Seamless body with concentric rings and cover, steam escape and extra plate perforated for test tubes.

	a	b	c
Diameter, inches	5	6	8
No. of Rings	4	5	7
Each	**$3.25**	**3.85**	**5.90**

3587 WATER BATH, POLISHED COPPER, tin-lined, seamless body, with concentric rings and cover, steam escape and extra plate perforated for test tubes.

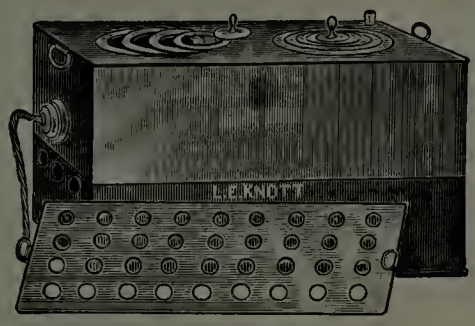
	a	b	c
Diameter, inches	5	6	8
No. of Rings	4	5	7
Each	**$2.90**	**3.25**	**5.25**

3590 WATER BATH, FUNNEL SHAPE, POLISHED COPPER, tin-lined. With concentric rings and constant water level. Height including tripod, 8 inches.

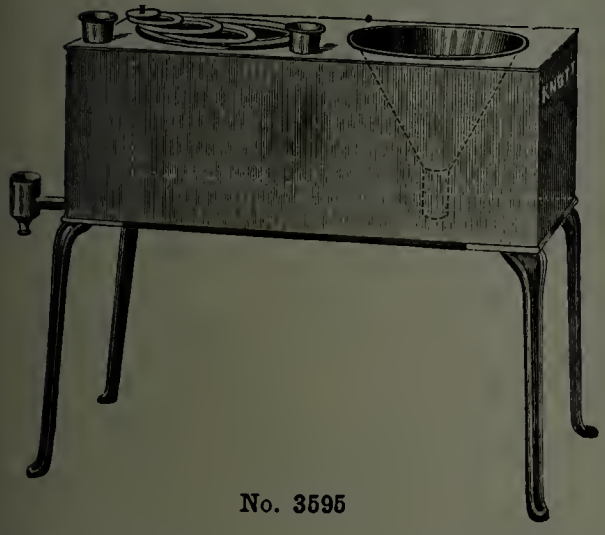
	a	b
Diameter, inches	6	8
No. of Rings	5	7
Each	**$3.90**	**4.85**

3593 WATER BATH, HOFFMAN'S, of heavy polished copper, with a set of concentric rings and plate with five holes of different sizes, each with cover. With constant water level. Diameter at top, 8 inches **$13.75**

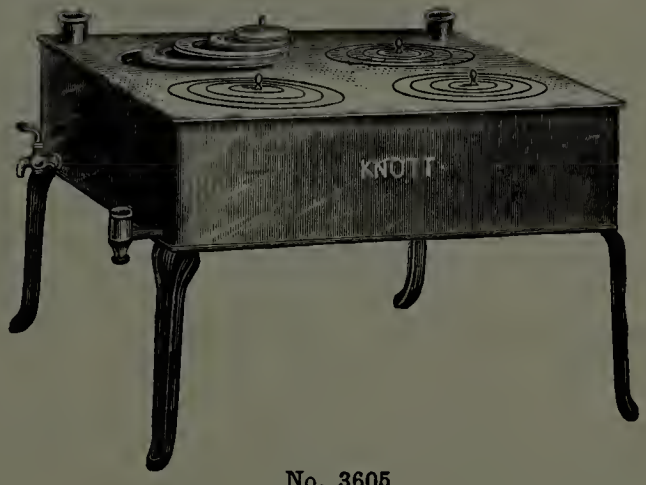
No. 3607



No. 3600



No. 3595



No. 3605

3595 **WATER BATH, GRIFFIN'S, POLISHED COPPER,** tin-lined for hot filtrations and evaporations. Provided with a constant water level, an extra sheet iron bottom and rests on four detachable legs. Size 13 × 7 × 5 inches deep. One 5-inch hole with four concentric rings and steam cover and one open with copper funnel **$11.50**

3600 **WATER BATH, ELECTRICALLY HEATED, POLISHED COPPER, tin-lined.** With two removable covers, one cover with two 5-inch openings and concentric rings, the other with thirty-six ⅞-inch holes for test tubes. Size 14½ × 6½ × 3 inches deep. Height over all 7½ inches. Provided with automatic cut-out that shuts off current if bath is allowed to run dry **32.50**

3605 **WATER BATH, POLISHED COPPER, tin-lined,** with concentric rings and steam cover. Provided with stopcock and Kekule's Water Level Regulator. With extra sheet iron bottom, and supported by four detachable legs. Size 14 × 14 × 5 inches deep. Four openings, 5 inches in diameter, with rings and steam cover **17.00**

3605A **WATER BATH, STEAM, POLISHED COPPER, tin-lined,** same as above, but arranged with coil to be heated by steam **20.75**

3605B **WATER BATH, ELECTRIC, POLISHED COPPER, tin-lined,** same as above, but arranged for electrical heating **39.25**

3607 **WATER BATH, POLISHED COPPER, tin-lined,** with concentric rings and cover, provided with stopcock and Kekule's Water Level Regulator. With extra sheet iron bottom supported by four detachable legs. Size 23 × 13½ × 5 inches deep. Seven openings, three of 6 inches diameter and four of 4 inches diameter with concentric rings and steam cover **23.50**

3607A **WATER BATH, STEAM, POLISHED COPPER, tin-lined,** same as above, but arranged with coil to be heated by steam **28.25**

3607B **WATER BATH, ELECTRIC, POLISHED COPPER, tin-lined,** same as above, but arranged for electrical heating **54.00**

3610 **WATER BATH, POLISHED COPPER, tin-lined,** with concentric rings and steam cover. Provided with stopcock and Kekule's Water Level Regulator. With extra sheet iron bottom and supported by four detachable legs. Size 28 × 14 × 5 inches deep, eight openings 5 inches in diameter with rings and steam cover **29.50**

3610A **WATER BATH, STEAM, POLISHED COPPER, tin-lined,** same as above, but arranged with coil to be heated by steam **34.25**

3610B **WATER BATH, ELECTRIC, POLISHED COPPER, tin-lined,** same as above, but arranged for electrical heating **58.50**

BATTERIES. See pages **320** to **325**.

BATTERY JARS. See pages **326** and **451**.

3615 **BEADS, GLASS,** hollow, for filtering and drying gases by means of acid . . . . . .Per pound **.95**

BEAKERS

Our line of **Beakers** has been selected with unusual care. We are confident that our customers will find not only the kind but also the quality desired.

We have given special attention to our Glass Beakers. We offer an exceptionally high grade glass in our Harcourt Line and, quality considered, we feel that this line cannot be excelled at even a much higher cost.

3625 BEAKERS, HARCOURT GLASS, low, wide Griffin form, with lip.

	a	b	c	d	e	f	g	h
No.	1	2	3	4	5	6	7	8
Capacity, cc.	75	100	200	300	400	600	800	1000
Each	**$0.10**	**.13**	**.16**	**.19**	**.24**	**.30**	**.35**	**.45**

3626 BEAKERS, HARCOURT GLASS, same as above, but nested as follows:

	a	b	c	d	e	f
No. in Nest	3	4	5	6	7	8
Size No.	1–3	2–5	1–5	1–6	1–7	1–8
Capacity, cc.	75–200	100–400	75–400	75–600	75–800	75–1000
Per Nest	**$0.39**	**.72**	**.82**	**1.12**	**1.47**	**1.92**

3628 BEAKERS, "PYREX" GLASS. (See index, **"Pyrex Glassware"** for characteristics.) Griffin low form, with lip.

	a	b	c	d	e	f	g	h	i	j	k	l
Capacity, cc.	50	100	150	250	400	600	800	1000	1300	1500	2000	2500
Each	**$0.13**	**.15**	**.17**	**.19**	**.27**	**.33**	**.38**	**.54**	**.65**	**.73**	**.98**	**1.13**

3629 BEAKERS, "PYREX" GLASS, same as above, but nested as follows:

	a	b	c	d	e	f
No. in Nest	3	4	5	6	7	8
Capacity, cc.	50–150	50–250	50–400	50–600	50–800	50–1000
Per Nest	**$0.45**	**.64**	**.91**	**1.24**	**1.62**	**2.16**

3631 BEAKERS, HARCOURT GLASS, wide, usual form, without lip.

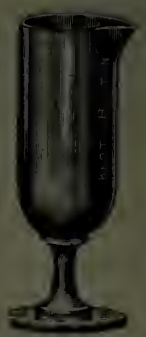
	a	b	c	d	e	f	g	h
Size No.	1	2	3	4	5	6	7	8
Capacity, cc.	75	100	200	300	400	600	800	1000
Each	**$0.10**	**.13**	**.16**	**.19**	**.24**	**.30**	**.35**	**.45**

3632 BEAKERS, HARCOURT GLASS, same as above, but nested as follows:

	a	b	c	d	e	f
No. in Nest	3	4	5	6	7	8
Size No.	1–3	2–5	1–5	1–6	1–7	1–8
Capacity, cc.	75–200	100–400	75–400	75–600	75–800	75–1000
Per Nest	**$0.39**	**.72**	**.82**	**1.12**	**1.47**	**1.92**

3635 BEAKER, VASE SHAPE, ON FOOT, for use on lecture desk for a large class of chemical experiments.

Capacity 350 cc **$0.60**



No. 3635

3638 BEAKERS, ALUMINUM, Griffin form, with lip.

	a	b	c
Capacity, cc.	250	500	1000
Each	**$0.66**	**1.00**	**1.50**

3640 BEAKERS, SPUN COPPER, polished, Griffin form, with lip.

	a	b	c
Capacity, cc.	250	500	1000
Each	**$0.66**	**.90**	**1.50**

3645 BEAKERS, PORCELAIN, without lip, glazed inside and outside, extensively used in testing of dye stuffs, etc.

	a	b	c
Capacity, cc.	340	580	970
Height, inches	4¾	5⅝	6⅝
Diameter, inches	3	3⅜	4
Each	**$1.00**	**1.25**	**1.75**

3650 BEAKERS, FUSED SILICA. (See index, **"Fused Silica Ware"** for characteristics.) With lip.

	a	b	c	d	e	f	g	h	i
Capacity, cc.	50	100	150	200	250	400	500	600	800
Each	**$0.90**	**1.00**	**1.10**	**1.20**	**1.45**	**1.70**	**1.95**	**2.20**	**2.65**

BELL GLASSES. See page **154.**

BIRDS

BIOLOGY AND NATURE STUDY

We have made arrangements with a leading taxidermist so that we carry the following:

3660 COLLECTION OF MOUNTED BIRDS FOR SCHOOL USE. Contains thirty of our common species representing the common orders. It includes *Grebe, Tern, Teal, *Heron, Rail, *Sandpiper, *Hawk, Owl, Kingfisher, *Woodpecker, *Kingbird, Phœbe, *Bluejay, *Crow, Cowbird, *Blackbird, Meadow Lark, Goldfinch, Native and English *Sparrow, Towhee, Scarlet Tanager, *Barn-Swallow, Red-Eyed Vireo, *Common Warbler, Catbird, House Wren, Chickadee, *American Robin, *Bluebird **$74.00**

3661 SKINS of the above, unmounted **35.00**

3663 FIFTEEN COMMON SPECIES representing those starred in above list . . . **38.00**

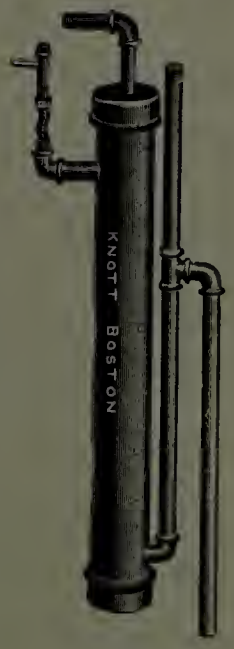
3664 SKINS, unmounted **18.00**

3666 COLLECTION OF EGGS, corresponding to above collection (in a few cases not identical with it in species) **5.40**

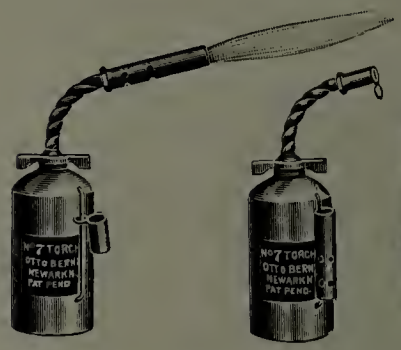
3667 COLLECTION OF EGGS, representing those starred in above list **2.75**

3675 BLAST APPARATUS, RICHARDS', for use where water pressure is available, in obtaining either blast or vacuum. Desirable for quick filtering and operating blast lamp. Complete with one Aspirator **9.75**

3676, ——, with two Aspirators **12.00**



No. **3675**



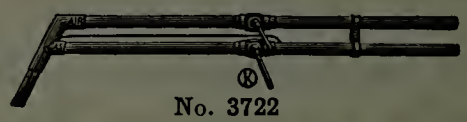
No. 3685

No. 3687

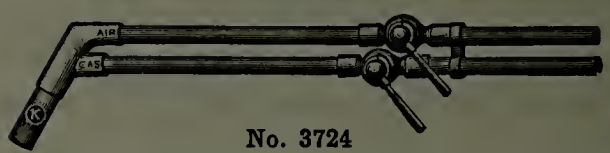
Nos. 3695 to 3697

Nos. 3699 to 3701

No. 3720



No. 3722



No. 3724

No. 3710 No. 3711

3685 **BLAST LAMP, GASOLINE, ¼ pint capacity,** giving a small hot flame, generating its own gas. With holder with cork-lined cap on side of the body for holding cleaner wire and nozzle when not in use. Will burn constantly for about three hours with one filling **$1.60**

3687 **BLAST LAMP, GASOLINE,** one pint capacity, giving an intensely hot blue flame which can be regulated to a small pointed flame or brush flame as desired. Of seamless drawn brass and fitted with an automatic brass pump **4.60**

For other **BLAST LAMPS** and **BURNERS,** see pages **200–202.**

BLOWERS, FOOT, for supplying a blast of air for lamps, blowpipes, etc. A rubber disc forms the air reservoir and equalizes the pressure by its elasticity. By increasing the number of discs a greater air pressure is obtained.

We list two styles, one with air reservoir above, the other with legs and air reservoir below.

3695 **BLOWER, FOOT, air reservoir above,** diameter of reservoir 7¼ inches, pressure of blast per inch one pound, cubic feet of air per hour 190.
With single disc **6.00**

3696 ——, diameter of reservoir 9 inches, pressure of blast per inch 1½ pounds, cubic feet of air per hour 330. With double disc **8.15**

3697 ——, diameter of reservoir 11 inches, pressure of blast per inch 1¾ pounds, cubic feet of air per hour 625. With three discs **12.90**

3699 **BLOWER, FOOT, with legs, air reservoir below.** Diameter of reservoir 7¼ inches, pressure of blast per inch one pound, cubic feet of air per hour 190. With single disc **6.85**

3700 ——, diameter of reservoir 9 inches, pressure of blast per inch 1½ pounds, cubic feet of air per hour 330. With double disc **9.35**

3701 ——, diameter of reservoir 11 inches, pressure of blast per inch 1¾ pounds, cubic feet of air per hour 625. With three discs **13.80**

3702 **RUBBER DISC,** made of the best quality para rubber, steam cured. 9⅛ inches diameter, for use with Blowers Nos. **3695** and **3699** . . . . . Each **.95**

3702A ——, same as above, but 11¼ inches diameter, for use on Blowers Nos. **3696** and **3700** . . . . . Each **1.35**

3702B ——, same as above, but 14¼ inches diameter, for use on Blowers Nos. **3697** and **3701** . . . . . Each **1.95**

3702C **BLOWER NETS,** as used on above Blowers . . . . . Each **.45**

3710 **BLOWPIPES,** of brass, plain.

	a	b
Length, inches	8	10
Each	**$0.22**	**.28**

3711 **BLOWPIPES,** of brass, with bulb.

	a	b
Length, inches	8	10
Each	**$0.35**	**.42**

3715 **BLOWPIPE MOUTH PIECE, trumpet shape,** hard rubber, 1¾ inches diameter **$0.40**

3715A **BLOWPIPE MOUTH PIECE, ordinary form,** of close grained hard wood, 1⅞ inches long . . . . . **.12**

3720 **BLOWPIPE, AUTOMATIC BRAZING,** nickel-plated, for light soldering. Length 10 inches . . . **2.45**

3722 **BLOWPIPE, AUTOMATIC BRAZING, with pilot light.** Small size, of brass, with two stopcocks, 5/16-inch air tube and ⅜-inch gas tube. Length 11 inches **1.95**

3724 **BLOWPIPE, AUTOMATIC BRAZING,** for general work. Of brass, with two stopcocks, 5/16-inch air tube and ⅝-inch gas tube. Length 16 inches **4.40**

3726 BLOWPIPES, GLASS BLOWERS' FIRES OR BURNERS. Two required, one mounted opposite to other. For use with foot blowers or other forms of blast. Each with three burners. Mounted as illustrated on stand. Per set of two **$14.75**

BONE CUTTING FORCEPS, see page **433**.

BONE SAW. See page **433**.

BOTANICAL MOUNTS. See **SPECIMEN MOUNTS,** page **480**.

BOTANICAL PRESS. See **PLANT PRESS,** page **472**.

No. 3736 No. 3735

No. 3726

No. 3737 No. 3738

3735 BOTTLES, prescription, narrow mouth.

	a	b	c	d	e	f
Capacity, ounces	1	2	4	8	16	32
Each	**$0.03**	**.04**	**.06**	**.09**	**.14**	**.20**

3736 BOTTLES, prescription, wide mouth.

	a	b	c	d	e	f
Capacity, ounces	1	2	4	8	16	32
Each	**$0.03**	**.04**	**.06**	**.09**	**.14**	**.20**

3737 BOTTLES, tincture, narrow mouth, with ground glass stopper.

	a	b	c	d	e	f
Capacity, ounces	1	2	4	8	16	32
Each	**$0.09**	**.10**	**.12**	**.16**	**.22**	**.35**

3738 BOTTLES, salt mouth, wide mouth with ground glass stopper.

	a	b	c	d	e	f
Capacity, ounces	1	2	4	8	16	32
Each	**$0.09**	**.10**	**.12**	**.16**	**.22**	**.35**

3740 BOTTLES, ACID or STORAGE, with ground glass stoppers.

	a	b
Capacity, pints	1	5
Each	**$0.16**	**.30**

No. 3742 No. 3745 No. 3747 No. 3749 No. 3751 No. 3753

3742 BOTTLE, ASPIRATOR, with tubulature for rubber tubing, capacity 32 ounces **$1.25**

3745 BOTTLE, BALSAM or DROPPING, triangular shaped ground glass stopper, drawn to a point, ground glass cap. Capacity 1½ ounces . . . . . **.35**

3747 BOTTLE, BALSAM or DROPPING, with ground glass cap and glass rod. Capacity 2 ounces . . . **.48**

3749 BOTTLE, DROPPING, bulb pipette, ground into the neck, forms an air-tight container. Capacity one ounce . . . . . **.36**

3751 BOTTLE, DROPPING (COBALT BOTTLE), with ball top, pipette ground in. Capacity one ounce **.48**

3753 BOTTLES, DROPPING, with grooves in neck and in stopper. When the grooves coincide, the contents may be poured out drop by drop. A quarter turn of the stopper closes the bottle air-tight.

	a	b
Capacity, ounces	1	2
Each	**$0.26**	**.30**

Vitrified Labels
Transparent Letters

REAGENT BOTTLES

Raised Ground
Glass Labels

With Indestructible Vitrified Labels—With Raised Ground Glass Labels—Transparent Letters.

Both types of Reagent Bottles listed are free from lead, zinc or other metallic flux. They are uniform in shape and the different capacities are uniform in height. The **Reagent Bottles** with **Raised Ground Glass Labels** have long been in use and can, therefore, be called the **Standard Type.** The variety of stock labels, however, is limited and many science laboratories have required us to furnish bottles which will have labels covering chemicals and reagents complete as used in science laboratories. Our **Reagent Bottles with Indestructible Vitrified Labels** meet this demand.

REAGENT BOTTLES WITH RAISED GROUND GLASS LABELS. ORDER BY CATALOGUE NUMBERS in the following listings. When no number is listed the **raised ground glass label cannot** be obtained, but to order, and **at an extra price,** the same shape and size may be obtained with label engraved on the bottle.

Capacity	Ounce	Ounce (Wide Mouth)	¼ Pint	¼ Pint (Wide Mouth)	½ Pint	Pint	Quart
Height, inches	3⅝	3⅛	5¼	4⅞	6½	7¾	9½
Per dozen	**$1.35**	**1.48**	**1.95**	**2.15**	**2.65**	**3.55**	**4.85**

REAGENT BOTTLES WITH INDESTRUCTIBLE VITRIFIED LABELS

These bottles have a **smooth white background** against which the **transparent letters and symbols** are clearly defined. Although higher in cost than Reagent Bottles above described, these bottles greatly enhance the appearance of the equipment and have the advantage that stock labels for practically all the chemicals and reagents used in science laboratories may be obtained. **ORDER BY CATALOGUE NUMBERS, in the following listings.** Where no number is listed, bottles with labels not on the list can be obtained but **at an extra price** and on order only.

Capacity	¼ Pint	¼ Pint (Wide Mouth)	½ Pint	Pint	Quart
Height, inches	5¼	5¼	6½	7¾	9½
Per Dozen	**$5.75**	**5.75**	**6.80**	**7.25**	**8.90**

Suggestive Equipments for Students' Desks, General Laboratory Use and Stock May Be Obtained on Application.

WITH INDESTRUCTIBLE VITRIFIED LABELS								WITH RAISED GROUND GLASS LABELS					
4 Ounces ¼ Pint (⅛ L)	WIDE MOUTH 4 Ounces ¼ Pint (⅛ L)	8 Ounces ½ Pint (¼ L)	16 Ounces Pint (½ L)	32 Ounces Quart (Liter)	SYMBOL	NAME	SYMBOL	Ounce	WIDE MOUTH Ounce	4 Ounces ¼ Pint (⅛ L)	WIDE MOUTH 4 Ounces ¼ Pint (⅛ L)	8 Ounces ½ Pint (¼ L)	16 Ounces Pint (½ L)	32 Ounces Quart (Liter)
401	402	801	1601	3201	$HC_2H_3O_2$	Acetic Acid	$HC_2H_3O_2$	—	—	R401	—	R801	—	—
403	404	803	1603	3203	C_2H_5OH	Alcohol	C_2H_5OH	—	—	R403	—	R803	—	—
405	406	805	1605	3205	NH_3	Ammonia	NH_3	—	—	R405	—	R805	—	—
409	410	809	1609	3209	$(NH_4)_2CO_3$	Ammonium Carbonate	$(NH_4)_2CO_3$	—	—	R409	—	R809	—	—
413	414	813	1613	3213	NH_4Cl	Ammonium Chloride	NH_4Cl	—	—	R413	—	R813	—	—
417	418	817	1617	3217	NH_4OH	Ammonium Hydroxide	NH_4OH	—	—	R417	—	R817	R1617	—
—	—	819	1619	—	———	Ammonium Hydroxide, Conc.	———	—	—	—	—	—	—	—
—	—	821	1621	3221	———	Ammonium Hydroxide, Dil.	NH_4OH+Aq	—	—	—	—	—	R1621	—
423	424	823	1623	3223	$(NH_4)_6Mo_7O_{24}$	Ammonium Molybdate	$(NH_4)_6Mo_7O_{24}$	—	—	R423	—	R823	—	—
427	428	827	1627	3227	$(NH_4)_2C_2O_4$	Ammonium Oxalate	$(NH_4)_2C_2O_4$	—	—	R427	—	R827	—	—
—	—	829	1629	3229	$(NH_4)_2HPO_4$	Ammonium Phosphate	$(NH_4)_2HPO_4$	—	R130	—	—	—	—	—
—	—	—	—	—	———	Ammonium Sodium Phosphate	$NaNH_4HPO_4$	—	R132	—	—	—	—	—
—	—	—	—	—	———	Ammonium Sulphate	$(NH_4)_2SO_4$	—	—	—	R434	—	—	—
437	438	837	1637	3237	$(NH_4)_2S$	Ammonium Sulphide (Amber)	$(NH_4)_2S$	—	—	R437	—	R837	R1637	—
441	442	841	1641	3241	NH_4CNS	Ammonium Sulphocyanide	NH_4CNS	—	—	R441	—	—	—	—
—	—	—	—	—	———	Ammonium Sulphydrate	NH_4HS	—	—	R443	—	—	—	—
—	—	845	1645	3245	$SbCl_6$	Antimonious Chloride	———	—	—	—	—	—	—	—
—	—	—	—	—	———	Barium Carbonate	$BaCO_3$	—	—	R447	—	—	—	—
449	450	849	1649	3249	$BaCl_2$	Barium Chloride	$BaCl_2$	—	—	R449	—	R849	R1649	—
451	452	851	1651	3251	$Ba(OH)_2$	Barium Hydroxide	$Ba(OH)_2$	—	—	R451	—	—	—	—
453	454	853	1653	3253	$Ba(NO_3)_2$	Barium Nitrate	$Ba(NO_3)_2$	—	—	R453	—	—	—	—
—	—	855	1655	3255	C_6H_6	Benzol	———	—	—	—	—	—	—	—
457	458	857	1657	3257	———	Blank	———	R157	R158	R457	R458	R857	R1657	—
—	—	—	—	—	———	Borax	$Na_2B_4O_7$	—	R160	—	R460	—	—	—
461	462	861	1661	3261	Br	Bromine Water	———	—	—	R461	—	—	—	—
463	464	863	1663	3263	$CaCl_2$	Calcium Chloride	$CaCl_2$	—	—	R463	—	—	—	—
—	—	865	1665	3265	$CaCl_2$	Calcium Chloride, Anhydrous	$CaCl_2$	—	—	R465	—	—	—	—
467	468	867	1667	3267	$Ca(OH)_2$	Calcium Hydroxide	$Ca(OH)_2$	—	—	R467	—	R867	R1667	—
—	—	—	—	—	———	Calcium Sulphate	$CaSO_4$	—	—	R469	—	—	R1669	—
—	—	871	1671	3271	———	Carbon Bisulphide	———	—	—	—	—	—	—	—
473	474	873	1673	3273	CS_2	Carbon Disulphide	CS_2	—	—	R473	—	—	—	—
—	—	875	1675	3275	———	Carbon Tetrachloride	———	—	—	—	—	—	—	—
477	478	877	1677	3277	Cl	Chlorine Water	———	—	—	—	—	—	—	—
—	—	879	1679	3279	$CHCl_3$	Chloroform	$CHCl_3$	—	—	R479	—	—	—	—
481	482	—	—	—	$H_3C_6H_5O_7$	Citric Acid	———	—	—	—	—	—	—	—
483	484	883	1683	3283	$Co(NO_3)_2$	Cobalt Nitrate	$Co(NO_3)_2$	R183	—	—	—	—	—	—
485	486	885	1685	3285	———	Cochineal	———	—	—	R485	—	—	—	—
—	488	—	—	—	Cu	Copper	Cu	—	R188	—	—	—	—	—
489	490	889	1689	3289	$CuSO_4$	Cupric Sulphate	$CuSO_4$	—	—	R489	—	—	—	—
491	492	891	1691	3291	———	Esbach's Solution	———	—	—	—	—	—	—	—
493	494	893	1693	3293	———	Ether	$(C_2H_5)_2O$	—	—	R493	—	—	R1693	—
—	—	895	1695	—	———	Ethyl Alcohol	———	—	—	—	—	—	—	—

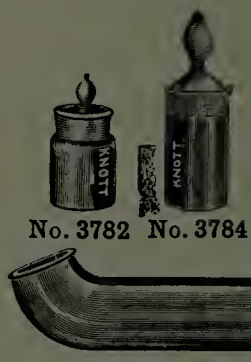
WITH INDESTRUCTIBLE VITRIFIED LABELS								WITH RAISED GROUND GLASS LABELS							
4 Ounces ¼ Pint (⅛ L)	WIDE MOUTH 4 Ounces ¼ Pint (⅛ L)	8 Ounces ½ Pint (¼ L)	16 Ounces Pint (½ L)	32 Ounces Quart (Liter)	SYMBOL	NAME	SYMBOL	Ounce	WIDE MOUTH Ounce	4 Ounces ¼ Pint (⅛ L)	WIDE MOUTH 4 Ounces ¼ Pint (⅛ L)	8 Ounces ½ Pint (¼ L)	16 Ounces Pint (½ L)	32 Ounces Quart (Liter)
497	498	897	1697	3297	———	Fehling's Alkaline Solution	———	———	———	———	———	———	———	———
499	500	899	1699	3299	———	Fehling's Copper Solution	———	———	———	———	———	———	———	———
501	502	901	1701	3301	———	Fehling's Solution	———	———	———	R501	———	———	———	———
503	504	903	1703	3303	$FeCl_3$	Ferric Chloride	Fe_2Cl_6	———	———	R503	———	———	———	———
505	506	905	1705	3305	$FeSO_4$	Ferrous Sulphate	$FeSO_4$	———	R206	R505	R506	R905	R1705	———
507	508	907	1707	3307	FeS	Ferrous Sulphide	FeS	———	R208	———	———	———	———	———
———	———	909	1709	3309	———	Formalin	———	———	———	———	———	———	———	———
511	512	911	1711	3311	———	Glycerine	———	———	———	———	———	———	———	———
———	———	———	———	———	———	Gold Chloride	$AuCl_3$	R213	———	———	———	———	———	———
———	———	915	1715	3315	HBr	Hydrobromic Acid, Dil	———	———	———	———	———	———	———	———
517	518	917	1717	3317	HCl	Hydrochloric Acid	HCl	———	———	R517	———	———	R1717	———
———	———	———	———	———	———	Hydrochloric Acid, Conc	HCl	———	———	R519	———	R919	R1719	R3319
521	522	921	1721	3321	HCl	Hydrochloric Acid, Dil	HCl	———	———	———	———	R921	———	R3312
———	———	923	1723	3323	HCN	Hydrocyanic Acid, Dil	———	———	———	———	———	———	———	———
525	526	925	1725	3325	H_2O_2	Hydrogen Peroxide	———	———	———	R525	———	———	———	———
529	530	929	1729	3329	H_2S	Hydrogen Sulphide (Amber)	H_2S	———	———	R529	———	R929	———	———
———	———	931	———	———	———	Hypophosphoric Acid, Dil	———	———	———	———	———	———	———	———
533	534	933	1733	3333	———	Indigo Solution	———	———	———	R533	———	———	———	———
535	536	935	1735	3335	I	Iodine	———	———	———	———	———	———	———	———
537	538	937	1737	3337	I+KI	Iodine Solution	I+KI	———	———	R537	———	———	———	———
———	———	939	1739	3339	$HC_3H_5O_3$	Lactic Acid	———	———	———	———	———	———	———	———
541	542	941	1741	3341	$Pb(C_2H_3O_2)_2$	Lead Acetate	$Pb(C_2H_3O_2)_2$	———	———	R541	———	R941	———	———
———	———	943	1743	3343	$Pb(NO_3)_2$	Lead Nitrate	———	———	———	———	———	———	———	———
———	546	———	———	———	———	Litmus Paper	———	———	———	———	———	———	———	———
———	———	947	1747	3347	———	Litmus Solution	———	———	———	R547	———	———	———	———
549	550	949	1749	3349	———	Magnesia Mixture	———	———	———	R549	———	———	———	———
551	552	951	1751	3351	$MgSO_4$	Magnesium Sulphate	$MgSO_4$	———	———	R551	———	———	———	———
553	554	953	1753	3353	MnO_2	Manganese Dioxide	———	———	———	———	———	———	———	———
555	556	955	1755	3355	$HgCl_2$	Mercuric Chloride	$HgCl_2$	———	———	R555	———	R955	———	———
———	———	957	1757	3357	$HgNO_3$	Mercurous Nitrate	$HgNO_3$	———	———	R557	———	———	———	———
———	———	959	1759	3359	CH_3OH	Methyl-Alcohol	CH_3OH	———	———	R559	———	———	———	———
561	562	961	1761	3361	———	Methyl Orange	———	———	———	R561	———	———	———	———
563	564	963	1763	3363	———	Millon's Reagent	———	———	———	———	———	———	———	———
565	566	965	1765	3365	———	Nessler's Solution	———	———	———	R565	———	———	———	———
———	———	967	1767	3367	$NiCl_2$	Nickel Chloride	———	———	———	———	———	———	———	———
569	570	969	1769	3369	HNO_3	Nitric Acid	HNO_3	———	———	R569	———	———	R1769	———
———	———	971	1771	———	———	Nitric Acid, Conc	HNO_3	———	———	R571	———	R971	R1771	R3371
———	———	973	1773	3373	HNO_3	Nitric Acid, Dil	HNO_3	———	———	———	———	R973	———	R3373
575	576	975	1775	3375	———	Nitro Hydrochloric Acid	———	———	———	———	———	———	———	———
———	———	977	1777	3377	———	Nitro Hydrochloric Acid, Dil	———	———	———	———	———	———	———	———
———	———	979	1779	3379	———	Nitro Sulphuric Acid	———	———	———	———	———	———	———	———
581	582	———	———	———	———	Oil Turpentine	———	———	———	———	———	———	———	———
583	584	983	1783	3383	$H_2C_2O_4$	Oxalic Acid	$H_2C_2O_4$	———	———	R583	———	———	———	———
585	586	985	1785	3385	C_6H_5OH	Phenol	———	———	———	R585	———	———	———	———
587	588	987	1787	3387	———	Phenolphthalein	———	———	———	R587	———	———	———	———
———	———	989	1789	3389	———	Phosphoric Acid, Dil	———	———	———	———	———	———	———	———
591	592	991	1791	3391	$PtCl_4$	Platinic Chloride	$PtCl_4$	R291	———	R591	———	———	———	———
593	594	993	1793	3393	$K_2Cr_2O_7$	Potassium Bichromate	$K_2Cr_2O_7$	———	———	R593	———	———	———	———
———	———	995	1795	3395	$KHSO_4$	Potassium Bisulphate	———	———	———	———	———	———	———	———
597	598	———	———	———	KBr	Potassium Bromide	———	———	———	———	———	———	———	———
599	600	999	1799	3399	K_2CO_3	Potassium Carbonate	K_2CO_3	———	———	R599	———	———	———	———
601	602	1001	1801	3401	$KClO_3$	Potassium Chlorate	$KClO_3$	———	R302	———	———	———	———	———
603	604	1003	1803	3403	K_2CrO_4	Potassium Chromate	K_2CrO_4	———	———	R603	———	———	———	———
605	606	1005	1805	3405	KCN	Potassium Cyanide	KCN	———	R306	———	R606	———	———	———
607	608	1007	1807	3407	$K_3Fe(CN)_6$	Potassium Ferricyanide	$K_3Fe(CN)_6$	———	R308	R607	———	———	———	———
609	610	1009	1809	3409	$K_4Fe(CN)_6$	Potassium Ferrocyanide	$K_4Fe(CN)_6$	———	———	R609	———	———	———	———
611	612	1011	1811	3411	KOH	Potassium Hydroxide	KOH	———	———	R611	———	R1011	R1811	———
613	614	1013	1813	3413	KI	Potassium Iodide	KI	———	———	R613	———	———	———	———
615	616	———	———	———	KNO_3	Potassium Nitrate	KNO_3	———	R316	———	R616	———	———	———
617	618	1017	1817	3417	$KNaC_4H_4O_6+4H_2O$	Potassium Sodium Tartrate	———	———	———	———	———	———	———	———
619	620	———	———	———	K_2SO_4	Potassium Sulphate	K_2SO_4	———	———	R619	———	———	———	———
621	622	1021	1821	3421	KSCN	Potassium Sulphocyanide	KSCN	———	———	R621	———	———	———	———
623	624	1023	1823	3423	$AgNO_3$	Silver Nitrate (Amber)	$AgNO_3$	R323	———	R623	———	R1023	———	———
———	———	———	———	———	———	Silver Sulphate	Ag_2SO_4	———	———	R625	———	———	———	———
627	628	1027	1827	3427	$NaC_2H_3O_2$	Sodium Acetate	$NaC_2H_3O_2$	———	R328	R627	———	———	———	———
———	———	———	———	———	———	Sodium Bitartrate	$NaHC_4H_4O_6$	———	R330	———	———	———	———	———
631	632	1031	1831	3431	$Na_2B_4O_7$	Sodium Borate	———	———	———	———	———	———	———	———
633	634	1033	1833	3433	Na_2CO_3	Sodium Carbonate	Na_2CO_3	———	R334	R633	R634	R1033	———	———
635	636	———	———	———	$NaClO_3$	Sodium Chlorate	———	———	———	———	———	———	———	———
———	———	———	———	———	———	Sodium Cobaltic Nitrite	———	———	———	R637	———	———	———	———
———	———	1039	1839	3439	$NaBrO_3$	Sodium Hydrobromate	———	———	———	———	———	———	———	———
641	642	1041	1841	3441	NaOH	Sodium Hydroxide	NaOH	———	———	R641	———	R1041	———	———
643	644	———	———	———	$NaPH_2O_2$	Sodium Hypophosphite	———	———	———	———	———	———	———	———
———	———	1045	1845	3445	$NaNO_3$	Sodium Nitrate	$NaNO_3$	———	R346	———	———	———	———	———
647	648	1047	1847	3447	Na_2HPO_4	Sodium Phosphate	———	———	———	R647	———	R1047	———	———
———	———	———	———	———	———	Sodium Thiosulphate	$Na_2S_2O_3$	———	———	R649	———	———	———	———
651	652	1051	1851	3451	$SnCl_2$	Stannous Chloride	$SnCl_2$	———	———	R651	———	R1051	———	———
———	654	———	———	———	———	Starch	———	———	R354	———	———	———	———	———
655	656	1055	1855	3455	H_2SO_4	Sulphuric Acid	H_2SO_4	———	———	R655	———	———	R1855	———
———	———	1057	1857	3457	H_2SO_4	Sulphuric Acid, Dil	H_2SO_4	———	———	———	———	R1057	———	R3457
———	———	———	———	———	———	Sulphuric Acid, Conc	H_2SO_4	———	———	R659	———	R1059	R1859	R3459
———	662	———	———	———	———	Test Paper	———	———	———	———	R662	———	———	———
663	664	1063	1863	3463	———	Turmeric	———	———	———	R663	———	———	———	———
———	666	———	———	———	Zn	Zinc	Zn	———	R366	———	———	———	———	———
———	———	1067	1867	3467	$ZnSO_4$	Zinc Sulphate	———	———	———	———	———	———	———	———

SUGGESTIVE EQUIPMENTS FOR STUDENTS' DESKS, GENERAL LABORATORY USE AND STOCK MAY BE OBTAINED ON APPLICATION

No. 3760

No. 31–140

No. 31–125



No. 3782 No. 3784

No. 3770 No. 3777

31–132 **BOTTLE, SPECIFIC GRAVITY (PYKNOMETER), not adjusted,** with perforated stopper ground into neck. Capacity 25 cc. **$0.30**

3760 **BOTTLES, SPECIFIC GRAVITY (PYKNOMETERS), accurately adjusted,** with perforated stoppers ground into necks.

	a	b	c	d
Capacity, cc.	10	25	50	100
Each	**$0.50**	**0.67**	**0.92**	**1.10**

31–140 **BOTTLE, SPECIFIC GRAVITY (PYKNOMETER), double wall with vacuum, accurately adjusted.** Capacity 25 cc. **2.15**

31–125 **BOTTLE, SPECIFIC GRAVITY (PYKNOMETER)** with **GROUND-IN CENTIGRADE THERMOMETER, accurately adjusted.** With stoppered capillary tube. Capacity 50 cc. **2.75**

3770 **BOTTLES, SPECIMEN,** Bent neck, square, — will lie flat.

	a	b	c
	Small	Medium	Large
Size, ounces	½	1	2
Per Dozen	**$0.94**	**1.10**	**1.22**

3775 **BOTTLES, WASHING, DRECHSEL'S,** with tubes ground into the neck.

	a	b	c
Capacity, cc.	125	250	500
Each	**$1.00**	**1.25**	**1.50**

3777 **BOTTLES, WASHING,** with antimony rubber stoppers and two bent tubes as illustrated.

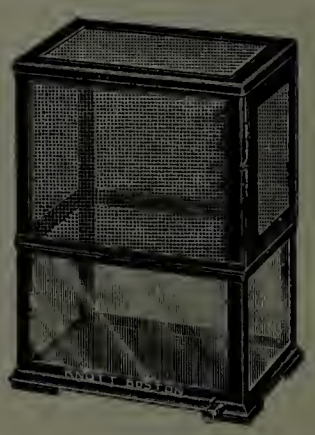
	a	b	c
Capacity, cc.	250	500	1000
Each	**$0.32**	**.42**	**.58**

3782 **BOTTLES, WEIGHING,** cylindrical, light blown glass, with shoulder and ground-in glass stopper.

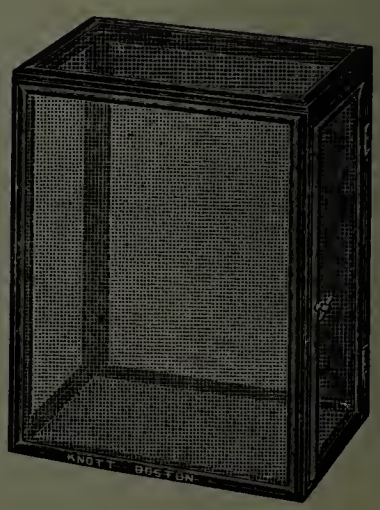
	a	b
Capacity, cc.	20	50
Each	**$0.40**	**.50**

3784 **BOTTLES, WEIGHING, flat bottom,** ground glass stopper.

	a	b
Diameter, mm.	25	40
Length, mm.	50	50
Each	**$0.46**	**.66**



No. 3792



No. 3790

3790 **BREEDING CAGE, HARCOURT, FOR INSECTS.** Wooden frame, solid bottom, gauze front, back, top and sides. One end hinged and provided with clasp. Outside dimensions 24 × 18 × 12 inches **$4.70**

3792 **BREEDING CAGE, KNOTT'S, FOR AQUATIC INSECTS.** Can also be used for wood boring larvæ, etc. This outfit is in reality a combination aquarium and breeding cage. The lower part is a substantially constructed aquarium 13½ × 8½ × 8 inches deep, inside dimensions. With glass front, back and ends, and provided with stopcock. The upper part measures 14 × 11 × 9 inches over all and is provided with glass front and gauze back and ends. One end is hinged and provided with clasp. Substantially framed in metal and painted throughout. Top removable. Dimensions over all 14¾ inches long, 10 inches wide, 20¼ inches high **13.75**

No. 3802 No. 3803

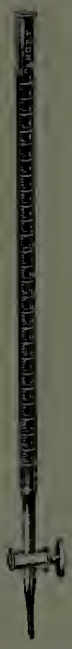
No. 3805

No. 3810

No. 3811

No. 3840

No. 3842



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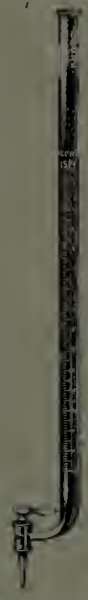

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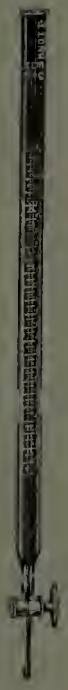

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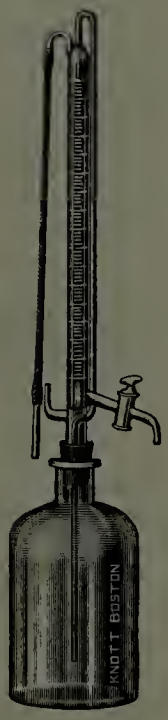

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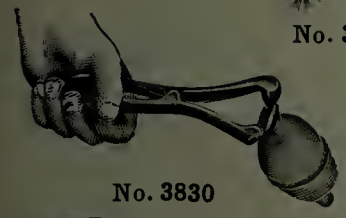

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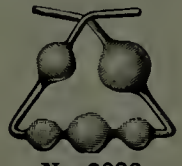


No. 3822

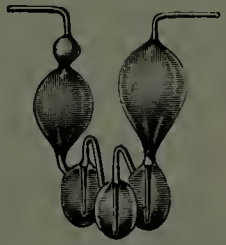
No. 3820

No. 3845

No. 3860

No. 3861

No. 3865



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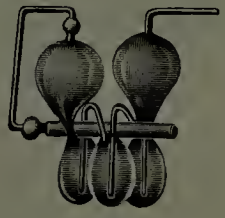


No. 3825

3800	**BRUSH, ACID,** of spun glass					$0.45
3802	**BRUSH, BEAKER or FUNNEL,** with long wooden handle					.22
3803	**BRUSH, BOTTLE,** with wood handle					.20
3805	**BRUSH, BURETTE, or TUBE,** with 3-foot wire handle					.10
16–250	**BRUSH, CAMEL'S-HAIR,** ½ inch wide, best quality					.16
3808	**BRUSH, "COUNTER,"** best quality. Should be in every laboratory					.50
3810	**BRUSH, TEST TUBE, bristle end,** wire handle					.07
3811	**BRUSH, TEST TUBE, sponge end,** wire handle					.07
3813	**BRUSH, TUBE, for narrow tubes,** wire handle					.03
3820	**BULB, CONNECTING, Hopkins' New Form**					.35
3822	**BULB, POTASH, Liebig's,** with five bulbs					.44
3824	**BULB, POTASH, Mohr's,** improved by Geissler					1.25
3825	**BULB, POTASH, Mohr's,** improved by Geissler, with **drying tube attached**					1.60
3830	**BULB EXPANDER,** for stretching necks of rubber bulbs					.50
3840	**BURETTES, MOHR'S,** for **pinchcock.** Without fittings. Subdivided into tenths.					
		a	b	c	d	
	Capacity, cc.	10	25	50	100	
	Each	$0.45	.66	1.00	1.80	
3842	**BURETTE, SCHELLBACH'S, Mohr's,** white back with color line, without fittings. 25 cc. × 1/10 cc.					$1.25
3843	——, 50 cc. × 1/10 cc.					1.48
3845	**ATTACHMENT,** Glass Tips, Rubber Tubing and Pinchcock for use with Nos. **3840, 3842** and **3843** above					.25
3850	**BURETTES, GEISSLER'S,** with straight glass stopcocks. Subdivided into tenths.					
		a	b	c	d	
	Capacity, cc.	10	25	50	100	
	Each	$1.40	1.55	1.90	2.70	
3852	**BURETTE, FRESENIUS',** 25 cc. × 1/10 cc.					$1.60
3853	——, 50 cc. × 1/10 cc.					2.20
3855	**BURETTE, SCHELLBACH'S,** Geissler's, white back with color line. 25 cc. × 1/10 cc.					1.60
3856	——, 50 cc. × 1/10 cc.					2.20
3860	**BURETTE CAPS** Per Dozen					.50
3861	**BURETTE FLOAT,** Erdmann's. When ordering, state the accurate inside diameter of the burette					.33
3865	**BURETTE FUNNELS** Each					.15
3870	**BURETTE, AUTOMATIC ZERO,** three-way stopcock for filling, discharging reservoir. 25 cc. × 1/10 cc.					5.25
3871	——, 50 cc. × 1/10 cc.					6.00

No. 3875

No. 3880

No. 3881

No. 3882

No. 3900

No. 3901

No. 3902

No. 3883

No. 3885

No. 3903

No. 3904

No. 3905

No. 3906

No. 3907

No. 3890

3875 **BURNER, HIGH TEMPERATURE** for either coal, natural or gasoline gas. Both air and gas can be regulated separately. The special feature of this burner is that the whole flame is practically uniform in temperature, eliminating entirely the cold air zone. Height 6½ inches with 1-inch grid **$1.85**

3880 **BURNER, TWO TUBE,** with air regulators. Height 6 inches, diameter of tubes 7/16 inch **1.30**

3881 **BURNER, THREE TUBE CLUSTER,** with air regulators. Height 6 inches, diameter of tubes 7/16 inch **1.60**

3882 **BURNER, FOUR TUBE CLUSTER,** with air regulators. Height 6 inches, diameter of tubes 7/16 inch **1.95**

3883 **BURNER, FOUR TUBE GANG,** with air regulators and stopcocks. Diameter of tubes 7/16 inch, height 8 inches **4.45**

3885 **BURNER, BUNSEN'S, FOUR TUBE GANG** with support and trough for heating tubes. With air regulators, stopcocks and wing tops. Complete as illustrated **9.25**

3890 **BURNERS, RING,** for heating funnels, etc. May be attached to any support.

	a	b	c
Diameter, inches	3	4	6
Each	**$1.30**	**1.50**	**1.90**

BURNERS, GLASS BLOWERS'. See **BLOWPIPES,** Page **415.**

BURNERS FOR SOLDERING IRONS. See **SOLDERING IRON HEATERS,** Page **479.**

For other **BURNERS,** see Pages **200-202.**

BURNER ATTACHMENTS

for

Burners with Tubes 7/16-Inch Diameter

3900 **BURNER TUBE** for blowpiping with yellow flame. Fits inside the burner **$0.13**

3901 **BURNER TIP** with rest for blowpipe . . . . . **.12**

3902 **BURNER CROWN** for heating small dishes. Gives a round flame . . . . . **.38**

3903 **BURNER GAUZE TOP** giving a large round flame . . . . . **.24**

3904 **BURNER WING TOP** for bending glass tubing, etc. . . . . **.09**

3905 **BURNER STAR** . . . . . **.21**

3906 **BURNER TRIPOD** . . . . . **.17**

3907 **BURNER CHIMNEY** of sheet iron, 2 inches diameter at the bottom . . . . . **.14**

CAGES, BREEDING. See Page 418.

CALCIUM CHLORIDE TUBES. See TUBES, Page 490.

3915 CALCIUM CHLORIDE HOLDER for balance cases $0.33

70–50A CANDLES, PARAFFINE, Sixes (six to the pound) . . . . . Per Dozen .33

70–50B CANDLES, PARAFFINE, Twelves (twelve to the pound) . . . . . Per Dozen .20

71–272 CANDLE, STANDARD, made of sperm, six to the pound. Will burn 120 grains (7.776 grams) per hour . . . . . Each .25

No. 3915

3925 CAPSULES, CIRCULAR, FUSED SILICA. (See index, "Fused Silica Ware," for characteristics.) Plain, glazed.

	a	b	c	d	e	f
Diameter, mm.	35	44	51	57	60	70
Depth in Center, mm.	13	13	13	13	13	16
Price, each	$0.60	.60	.90	.90	1.00	1.25

3927 CAPSULES, IGNITION, ALUNDUM. (See index, "Alundum Ware," for characteristics.)

	a	b	c	d
Diameter, inches	1 1/32	1 7/16	1 5/8	1 3/4
Height, inches	7/16	5/8	5/8	7/8
Capacity, cc.	7	10	18	25
Each	$0.28	.33	.38	.44

3929 CAPSULES, RECTANGULAR, FUSED SILICA. (See index, "Fused Silica Ware," for characteristics.) Glazed.

	a	b	c
Length, mm.	56	48	63
Width, mm.	24	38	35
Depth, mm.	10	16	10
Each	$1.00	1.00	1.25

CARDS, LOGARITHM. See LOGARITHM CARDS, Page 452.

3931 CASSEROLES, AGATE WARE, with attached handle.

	a	b	c	d
Capacity, cc.	250	500	750	1000
Each	$0.20	.22	.28	.30

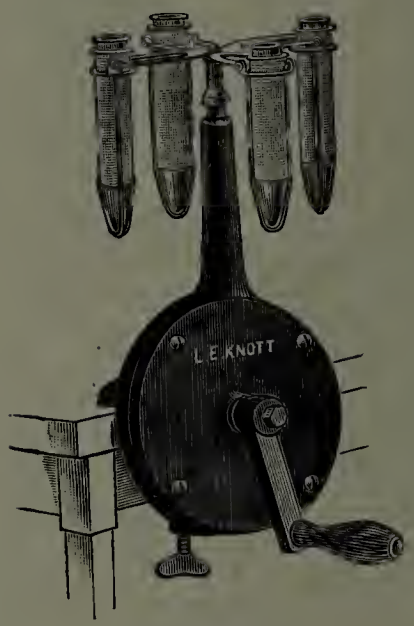
3934 CASSEROLES, PORCELAIN, with porcelain handle.

	a	b	c	d	e
Capacity, cc.	125	190	375	625	1000
Each	$0.50	.60	1.00	1.75	2.00

3938 CASSEROLES, FUSED SILICA. (See index, "Fused Silica Ware," for characteristics.)

	a	b	c	d	e
Diameter, mm.	51	70	82	95	108
Depth, mm.	25	35	44	51	63
Each	$1.75	2.15	2.65	3.40	4.40

CENTRIFUGES



No. 3945

No. 3950

No. 3955

3945 **CENTRIFUGE, DOUBLE ARM, HAND DRIVE,** accurately cut phosphor-bronze gears with Babbitt metal bearing and ball-bearing rest. Entirely dust-proof. Relief clutch in handle makes it impossible to stop suddenly and disturb sediment in the glass tubes. New style holder eliminates danger of breaking the tubes. Speed, 2000 to 2500 R. P. M., obtained with ease and entire safety.
Complete with two plain and two graduated 15-cc. glass tubes **$13.50**

CENTRIFUGE, ELECTRIC, for use on 110 or 220 volts D. C. and A. C. Circuits, on direct current approximately 1500 R. P. M., on alternating current, approximately 1300 R. P. M. Prices include attachment cord and plug, with rotating head with metal tubes. Glass parts are extra as listed.

3948 ——, **for 110 volts, D. C.** With Rheostat **24.75**

3950 ——, **for 110 volts, A. C.** Without Rheostat (not required) **22.25**

3952A **PLAIN GLASS TUBES,** 15 cc. for above centrifuges . . . . . Each **.12**

3952B **GRADUATED GLASS TUBES,** 15 cc. for above centrifuges . . . . . Each **.45**

3952C **RUBBER CAPS** for above tubes . . . . . Each **.08**

3955 **CENTRIFUGE, ELECTRIC, DOUBLE ARM, for blood, sputum, and milk analysis.** Enclosed rheostat for control of speed. Can be used on both direct and alternating current at 110 volts, but not advised or guaranteed on direct current for a longer period than three to five minutes. Improved tube holder eliminates danger of breaking the tubes.
Complete with two plain and two graduated 15-cc. tubes and six feet of electric cord with plug . . . **34.00**
NOTE:—When either direct or alternating current is available, it is advisable to order this Centrifuge for the particular current on which the motor is to be run.

CENTRIFUGE ACCESSORIES

3957 **PLAIN GLASS TUBE,** 15 cc. **$0.12**

3958 **GRADUATED GLASS TUBE,** 15 cc. . . . . **.45**

3959 **HAEMATOKRIT,** with tubes for examination of blood and sputum **4.90**

3970 **CHARCOAL BLOCKS** for blowpipe work . . . . . Per Dozen **.45**

3975 **CHART, ATOMIC WEIGHT,** compiled by Dr. F. W. Clarke and reported to the American Chemical Society. Corrected to 1911. Length 62 inches; mounted on common rollers **1.35**

3976 **CHART, PERIODIC LAW,** according to Mendelejeff, on basis of O=16. Revised and corrected by Dr. F. W. Clarke, up to 1911. American nomenclature. Length 62 inches; mounted on common rollers **1.50**

77–80 **CHART, SPECTRUM,** after Kirchhoff and Bunsen, showing beautifully the spectrum of the sun, K, Rb, Cs, Tl, Na, Li, Ca, Sr and Ba. Mounted on linen back with common rollers **4.25**

77–82 **CHART, SPECTRUM,** after Kirchhoff and Bunsen, showing the following spectra, — In, C, Bo, Mn, Pb, Cu, Co, Ni and Fe. Mounted on linen back with common rollers **4.25**

6895 **CHLORINE TUBE,** after Newell's "Descriptive Chemistry," Experiment **23**, and "General Chemistry," Experiment **29** . . . . . **.77**

No. 4000

No. 4002

No. 4004

No. 4006

No. 4008

No. 4013

No. 4015

Nos. 4011 and 4017

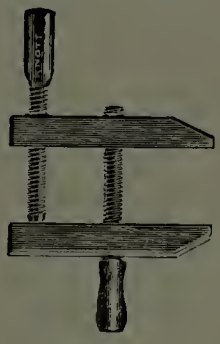
No. 4025

No. 4030

No. 4032

No. 4034

No. 4020


No. 4022

No. 4040

No. 4042

4000 **CLAMP, BURETTE, with attached Clamp Holder.** Check nut to adjust to any position, cork-lined jaws open to 1½ inches **$0.33**

4002 **CLAMP, DOUBLE BURETTE,** closes automatically by means of coiled springs; cork-lined jaws . . **.80**

4004 **CLAMP, DOUBLE BURETTE, HOFFMAN'S,** opening 1¼ inches, length 7 inches . . . . . **.95**

4006 **CLAMP, BUNSEN'S,** for attaching to support rods of ring stands by means of Clamp Holder. Cork-lined **round** jaws open to 1½ inches. Without Clamp Holder . . . . . **.30**

4008 **CLAMP, BUNSEN'S,** for attaching to support rods of ring stands by means of Clamp Holder. **One** flat and one **V-shaped** cork-lined jaw. Opens to 2 inches. Without Clamp Holder . . . . . **.38**

4011 **CLAMP HOLDER** for use with either of above clamps . . . . . **.16**

4013 **CLAMP, BUNSEN'S QUICK ACTING,** compound lever adjustment. Jaws open to 1½ inches. Adjustment to full opening of the jaws by one-half turn of the turn buckle **1.25**

4015 **CLAMP, BUNSEN'S CONDENSER,** for attaching to support rod of ring stands by means of Clamp Holder. With swivel cork-lined jaws which adapt themselves to regular or irregular shapes. Jaws open to 2½ inches. Without Clamp Holder . . . . . **.80**

4017 **CLAMP HOLDER** for use with either of above clamps . . . . . **.16**

4020 **CLAMPS, CABINET MAKERS',** of malleable iron, japanned, with ball and socket, swivel cap and screw.

	a	b	c
Open, inches	3	4	6
Each	**$0.28**	**.38**	**.60**

4022 **CLAMPS, HAND SCREW,** of wood, superior quality.

	a	b	c
Length of Jaws, inches	7	8	10
Open, inches	3	4½	5½
Each	**$0.40**	**.48**	**.60**

4025 **CLAMP, "CUT-OFF,"** of brass, nickel-plated, for tubes up to 3/16-inch diameter . . . . . **.03**

4026 **CLAMP, "CUT-OFF," nickel-plated,** with 5/16-inch opening . . . . . **.05**

4030 **CLAMPS or SCREW COMPRESSORS, of brass, nickel-plated.** Can be placed upon tube without disconnecting the apparatus.

	a	b
Size, inches	½ × ¾	¾ × 1¼
Each	**$0.25**	**.30**

4032 **CLAMPS, HOFFMAN'S SCREW COMPRESSORS,** nickel-plated.

	a	b
Size, inches	½ × ¾	½ × 1
Each	**$0.25**	**.30**

4034 **CLAMP, LEVER SCREW COMPRESSOR,** for heavy walled tubing, of brass, nickel-plated, nicely finished with rounded edges. Size, ½ inch . . . . . **.30**

4036 **CLAMPS, MOHR'S PINCHCOCKS,** of brass, nickel-plated.

	a	b	c
	Small	Medium	Large
Length, inches	2¼	2¾	3¼
Each	**$0.10**	**.12**	**.15**

4040 **CLAMP, TEST TUBE,** of spring wire. Will hold test tubes from ½ to 1½ inches diameter. Will not burn . . . . . **.08**

4042 **CLAMP, TEST TUBE,** of wood, with wire spring . . . . . **.08**

6305 **CLAY PIPES** . . . . . Per Dozen **.16**

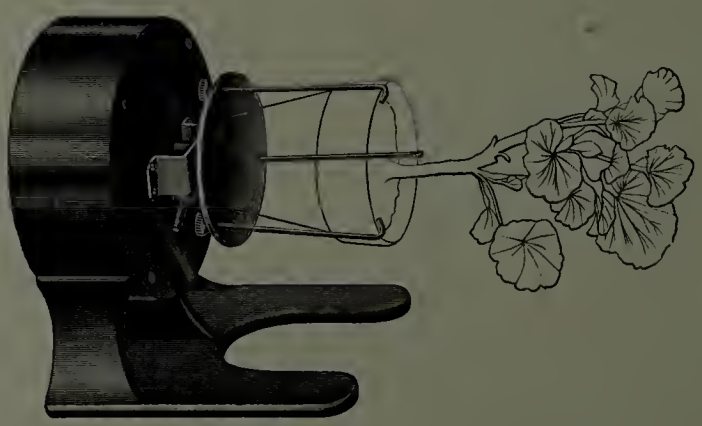
HARCOURT CLINOSTATS

STUDENTS' — ADVANCED

No. 4050
Showing Pot mounted vertically

No. 4050
Showing Pot mounted horizontally

4050 HARCOURT STUDENTS' CLINOSTAT for small pots or especially for seeds growing in moss. Consists of a 24-hour clock enclosed in a practically dust and moisture-proof case of cast metal. Designed so that shaft may be used horizontally or vertically **$7.50**



No. 4052
Showing Pot mounted horizontally

No. 4052
Showing Pot mounted vertically

4052 HARCOURT ADVANCED CLINOSTAT for pots up to 3 inches horizontally or larger vertically or for seeds growing in moss. This clinostat consists essentially of an eight-day clock enclosed in a practically dust and moisture-proof casing of cast metal. A 3-inch pot is recommended, as the instrument works best with this size. A 4-inch pot may be used, however, especially in the vertical position. Complete with set of clamps for holding pot as illustrated **$15.00**

4065 COMBUSTION BOATS, ALUNDUM. (See index, "Alundum Ware," for characteristics.)
Valuable for all kinds of determinations involving combustions at high temperatures, particularly well suited for conditions met in the determination of carbon in iron and steel. Wall, 1/16 inch.

	a	b	c	d	e
Length, inches	3 1/2	3 3/4	4 1/2	5	5 1/2
Width, inches	1/2	5/8	5/8	3/4	1/2
Height, inches	5/16	3/8	7/16	7/16	5/16
Each	**$0.33**	**.38**	**.45**	**.45**	**.45**

4067 COMBUSTION BOAT SHIELDS, ALUNDUM. (See index, "Alundum Ware," for characteristics.)
For protecting combustion boats from the spattering of overheated metal. Wall, 1/32 inch.

	a	b
Length, inches	4 1/2	5 1/2
Bore, inches	11/16	13/16
Each	**$0.83**	**1.10**

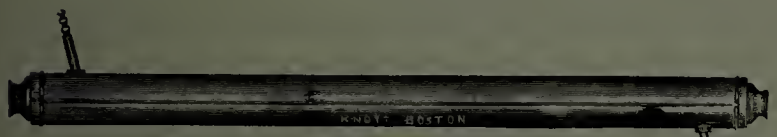
COMBUSTION BOATS, PLATINUM. See **PLATINUM WARE**, page **473**.

4069 COMBUSTION BOATS, ROYAL WORCESTER PORCELAIN. (See index, "Royal Worcester Porcelain Ware," for characteristics.)

	a	b	c	d
Length, mm.	60	75	75	100
Width, mm.	10	11	15	18
Each	**$0.22**	**.30**	**.35**	**.55**

4071 COMBUSTION BOATS, FUSED SILICA. (See index, "Fused Silica Ware," for characteristics.)

	a	b	c	d	e
Length, mm.	44	76	76	102	152
Width, mm.	13	13	16	16	12
Depth, mm.	8	8	10	10	12
Each	**$0.50**	**.75**	**.90**	**1.15**	**1.50**



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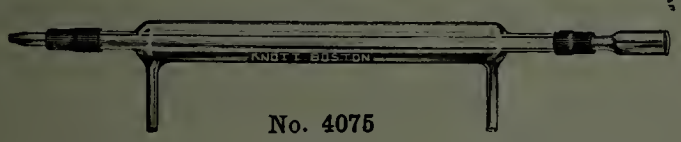

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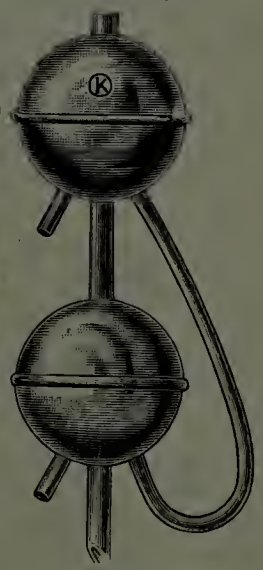
No. 4079



No. 4081

COMBUSTION FURNACES. See **FURNACES**, pages **440** to **443**.

4075 CONDENSERS, LIEBIG'S, GLASS, with rubber connections and adapters.

	a	b	c
Length, inches	12	15	18
Each	**$0.95**	**1.25**	**1.40**

4077 CONDENSER, LIEBIG'S, METAL, for the distillation of liquids, made entirely of brass, highly polished. Length 30 inches; diameter 1 7/8 inches. This form prevents breakage **$2.75**

4079 CONDENSER, SOXHLET'S BALL, copper, tinned inside, for use with extraction apparatus. Polished and nickel-plated. Diameter 4 inches **3.00**

4081 CONDENSER, SOXHLET'S DOUBLE, same as above, but with two bulbs, 4 inches in diameter. Connected as illustrated **8.25**

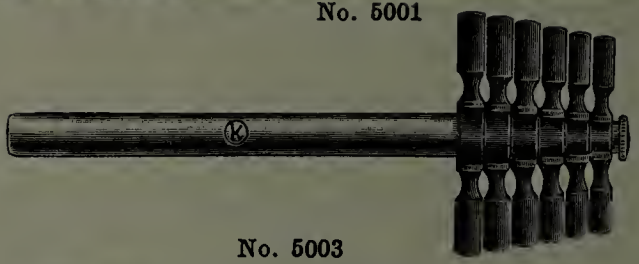
4085 CONDENSERS, ZINC, with pure block tin worm.

	a	b	c	d	e
Capacity, gallons	1/2	1	2	3	5
Each	**$5.50**	**6.50**	**8.00**	**11.00**	**15.00**

90-310 CONNECTORS, DOUBLE . . . . . Each **.11**

90-315 CONNECTORS, TRIPLE . . . . . Each **.18**

No. 5001



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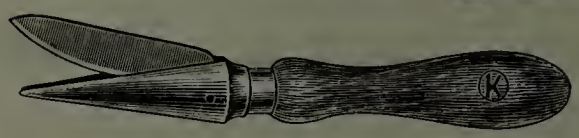


No. 5005

No. 5017

Nos. 5014 and 5015

No. 5013

4095 CORKS, REGULAR LENGTH, TAPERED, excellent quality.

Nos.	0	1	2	3	4	5
Length, inches	3/8	1/2	1/2	1/2	1/2	5/8
Diameter large end, inches	3/8	7/16	1/2	9/16	5/8	11/16
Per Dozen	$0.03	.03	.03	.03	.04	.04
Per Gross	$0.15	.16	.17	.20	.23	.30
Nos.	6	7	8	9	10	11
Length, inches	5/8	3/4	3/4	3/4	1	1
Diameter large end, inches	3/4	13/16	7/8	15/16	1	1 1/16
Per Dozen	$0.05	.06	.07	.08	.09	.10
Per Gross	$0.33	.44	.55	.65	.80	.90
Nos.	12	13	14	15	16	17
Length, inches	1	1	1	1	1	1
Diameter large end, inches	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 7/16
Per Dozen	$0.12	.12	.14	.15	.18	.20
Per Gross	$1.00	1.05	1.20	1.35	1.70	1.85
Nos.	18	19	20	22	24	26
Length, inches	1	1	1	1	1	1
Diameter, large end, inches	1 1/2	1 9/16	1 5/8	1 3/4	1 7/8	2
Per Dozen	$0.22	.26	.30	.35	.42	.54
Per Gross	$1.95	2.10	2.20	2.90	3.40	3.90

4097 CORKS, SPECIE, FLAT or JAR, excellent quality, 5/8 inch thick.

	a	b	c	d	e	f	g	h
Diameter, large end, inches	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4
Per Dozen	$0.08	.11	.15	.20	.25	.32	.42	.55

4099 CORKS, ASSORTED, Nos. 0 to 11 . . . . . Per Gross $0.40

CORKS, RUBBER. See Rubber Stoppers, Page 478.

5001 CORK BORERS, of hard metal with sharp cutting edge; polished, in sets with punch.

	a	b	c	d
No. in Set	3	6	9	12
Per Set	$0.55	.90	1.50	2.00

5003 CORK BORERS, of hard drawn metal with sharp cutting edge, each borer with handle.

	a	b	c	d
No. in Set	3	6	9	12
Per Set	$0.98	2.15	2.65	3.75

5005 CORK BORER SHARPENER, a steel blade, and cone of brass, wood handle 1.25

5007 CORK KNIFE, good steel blade, wood handle 18

5010 CORK MATS for supporting beakers, flasks, etc.

	a	b
Diameter, inches	4	6
Each	$0.09	.14

5013 CORK PRESS, Lever Form, japanned 25

5014 CORK PRESS, ROTARY, wheel form, taking corks up to 3/4-inch diameter, japanned 60

5015 CORK PRESS, ROTARY, wheel form, taking corks up to 1 1/4 inches diameter, japanned 85

5017 CORK SCREW, excellent quality, wood handle 18

5020 CORK SHEET for lining insect boxes and cabinets, 10 × 30 mm. × 5 mm. thick 14

COVER GLASSES. See page 461.

5030 **CRUCIBLES, ALUNDUM.** (See index, "Alundum Ware," for characteristics.) For general laboratory use where an ignition of carbonaceous material is involved. Without covers.

	a	b	c	d	e	f	g	h	i
Diameter at Top, inches	$1\frac{1}{16}$	$1\frac{1}{16}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{7}{8}$	$1\frac{7}{8}$	$2\frac{1}{2}$	$2\frac{1}{2}$
Height, inches	$1\frac{3}{32}$	$1\frac{1}{4}$	$1\frac{3}{16}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{5}{8}$	$1\frac{7}{8}$	$1\frac{3}{4}$	3
Capacity, cc.	10	15	20	25	30	40	70	80	95
Each	**$0.28**	**.33**	**.34**	**.40**	**.41**	**.42**	**.43**	**.44**	**.85**

5031 **CRUCIBLE COVER, ALUNDUM,** diameter $1\frac{1}{2}$ inches **$0.33**

5031A ——, diameter $1\frac{7}{8}$ inches . . . . . **.38**

5033 **CRUCIBLES, GRAPHITE,** Dixon's genuine. Capacities given are actual total, not working capacities, which are variable.

	a	b	c	d	e
Capacity, ounces	2	4	8	12	16
Height, inches	$2\frac{1}{4}$	$2\frac{15}{16}$	$3\frac{5}{8}$	$4\frac{1}{2}$	$5\frac{1}{4}$
Diameter, inches	$1\frac{13}{16}$	$2\frac{3}{8}$	$3\frac{1}{4}$	$3\frac{3}{4}$	$4\frac{1}{4}$
Each	**$0.52**	**.52**	**.92**	**1.05**	**1.12**

Nos. 5035 and 5039

No. 5037

5035 **CRUCIBLES, SHEET IRON, with Covers.**

	a	b	c	d
Capacity, cc.	20	50	100	200
Each	**$0.24**	**.28**	**.33**	**.40**

5037 **CRUCIBLE, SKIDMORE'S IRON,** for making oxygen from MnO_2, calcination of chalk with recovery of the expelled CO_2, manufacture of soda from cryolite, preparation of ammonia, destructive distillation of coal, wood or other organic substance, or for any use in which the materials employed or evolved do not act destructively on hot iron. Can be used equally well as an open crucible, closed crucible or retort. Capacity $1\frac{1}{2}$ ounces **$0.98**

5039 **CRUCIBLES, SHEET NICKEL, with covers.**

	a	b	c	d
Capacity, cc.	20	30	50	100
Each	**$0.94**	**1.10**	**1.20**	**1.95**

CRUCIBLES, PLATINUM. See **PLATINUM WARE.**

5042 **CRUCIBLES, PORCELAIN,** excellent quality, well adapted to general chemical work in the laboratory.

	a	b	c	d	e	f	g
Capacity, cc.	13	14	25	45	80	140	280
Diameter at Top, mm.	33	41	46	55	69	82	86
Diameter at Bottom, mm.	15	17	20	21	27	32	40
Height, mm.	25	25	30	39	45	54	72
Each	**$0.20**	**.27**	**.35**	**.42**	**.55**	**.60**	**.74**

5043 **CRUCIBLES, PORCELAIN, ROYAL WORCESTER.** (See index, "Royal Worcester Porcelain Ware," for characteristics.) Glazed inside and outside, with covers and rings.

	a	b	c	d	e	f	g	h
Diameter at Top, mm.	32	37	41	46	56	67	81	96
Diameter at Bottom, mm.	13	15	15	18	18	23	29	35
Height, mm.	19	21	25	29	36	44	52	65
Capacity, cc.	8	12	17	30	50	90	145	265
Each	**$0.20**	**.22**	**.30**	**.38**	**.52**	**.57**	**.66**	**.85**

5045 **CRUCIBLES, GOOCH, PORCELAIN, ROYAL WORCESTER.** (See Index, "Royal Worcester Porcelain Ware," for characteristics.) Thin wall, bottom unglazed, outside and inside glazed.

	a	b	c
Diameter at Top, mm.	27	35	40
Diameter at Bottom, mm.	18	22	25
Height, mm.	30	40	43
Capacity, cc.	10	25	35
Each	**$0.34**	**.48**	**.58**

5048 **CRUCIBLES, FUSED SILICA.** (See index, "Fused Silica Ware," for characteristics.) Glazed. Berlin porcelain shape. Measurements given are outside measurements.

	a	b	c	d	e	f
Height, mm.	19	25	28	37	44	51
Diameter at Top, mm.	41	41	48	57	67	81
Crucibles, each	**$0.60**	**.60**	**.75**	**.90**	**1.25**	**1.50**
Lids to Fit, each	**$0.50**	**.50**	**.60**	**.75**	**.90**	**1.10**

5049 **CRUCIBLES, FUSED SILICA.** (See index, "Fused Silica Ware" for characteristics.) Unglazed. Measurements are outside measurements.

	a	b	c	d	e	f	g	h	i
Height, mm.	111	102	156	190	196	213	260	324	508
Diameter at Top, mm.	95	108	114	127	149	158	196	257	305
Each	**$2.15**	**2.15**	**3.15**	**3.75**	**4.00**	**5.00**	**8.00**	**12.50**	**18.00**

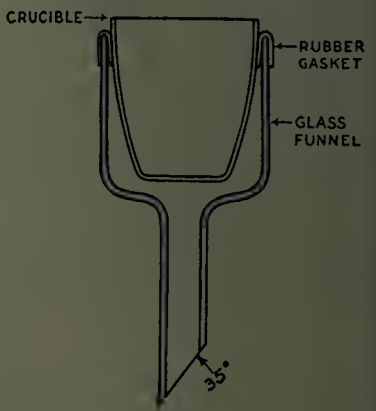
5050 **CRUCIBLES, FUSED SILICA.** (See index, "Fused Silica Ware," for characteristics.) Glazed. Platinum shape.

	a	b	c
Height, mm.	51	35	38
Diameter at Top, mm.	51	35	43
Crucibles, each	**$1.25**	**1.25**	**1.25**
Lids to Fit, each	**$0.60**	**.50**	**.50**

5051 **CRUCIBLE, FUSED SILICA, GOOCH,** ¾-inch hole in bottom, without disc. (See index, "Fused Silica Ware," for characteristics.) Outside measurements, — height 1⅝ inches (41 mm.), diameter at top 1⅝ inches (41 mm.) Glazed **$1.50**

5052 **CRUCIBLE, FUSED SILICA, SPECIAL.** (See index, "Fused Silica Ware," for characteristics.) Glazed. Outside measurements, — height $3\frac{3}{16}$ inches (81 mm.), diameter at top 2⅞ inches (73 mm.) **2.50**

5055 **CRUCIBLE, FILTER, ALUNDUM,** for the separation of liquids from solids in laboratory practice. For rapid filtration, it is necessary to maintain a reduced pressure as secured by an aspirator, etc. Special glass funnels and rubber gaskets are necessary to give the proper fit between the container and filtering medium. Three degrees of porosity may be obtained, — 36.9 per cent., 40.7 per cent. and 47.4 per cent. We carry in stock, however, 40.7 per cent. only. Diameter 1⅜ inches, height 1½ inches, capacity 25 cc. **$0.35**



Proper method of supporting Alundum Crucible

5055A **GLASS SUPPORTING FUNNEL** for use with above Crucible and Rubber Gasket following, in making close connection with the filtering medium . . . . . **.42**

5055B **RUBBER GASKET** for use with above Filter Crucible and Supporting Funnel in making close connection with the filtering medium . . . . . **.08**

5056 **CRUCIBLE, FILTER, ALUNDUM,** same as No. **5055**, but 1⅝ inches diameter, $1\frac{11}{16}$ inches high and 35 cc. capacity . . . . . **.42**

5056A **GLASS SUPPORTING FUNNEL** for use with above Crucible and Rubber Gasket following, in making close connection with the filtering medium . . . . . **.48**

5056B **RUBBER GASKET** for use with the above Filter Crucible and Supporting Funnel in making a close connection with the filtering medium . . . . . **.08**

No. 5060

No. 5063

No. 5067

Nos. 5075 and 5076

5060 **CRUCIBLE, ROSE'S,** with perforated cover and delivery tube, unglazed, vitreous. Capacity 30 cubic centimeters $0.60

5063 **CRUCIBLES, SAND,** round form with lip.

	a	b	c	d	e
Height, inches	2⅝	3	3½	4	4½
Diameter, inches	1⅝	1⅞	2¼	2⅜	2⅞
Per Dozen	$0.42	.78	.84	.96	1.44

5065 **CRUCIBLE BLOCKS** for No. 0 Porcelain Crucibles, according to specifications by Dr. Lyman C. Newell . . . . . Per Dozen .80

5067 **CRUCIBLE FUNNEL,** of glass, according to Dr. Lyman C. Newell 20

5069 **CRUCIBLE RUBBER TUBING** for connecting Gooch Crucible and Funnel . . . . . Per Foot .30

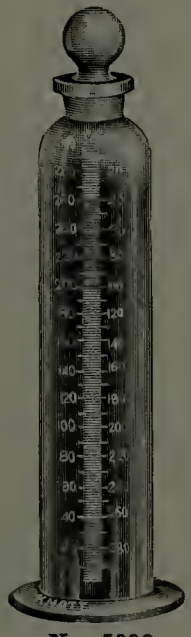
5075 **CRUCIBLE TONGS,** steel, double bend, 9-inch 22

5076 **CRUCIBLE TONGS,** steel, nickel-plated, double bend, 9-inch 33

CULTURE TUBES. See **TUBES, CULTURE,** Page **490.**

No. 31–250

No. 5095



No. 5098

5080 **CUPS, POROUS.**

	a	b	c	d
Diameter, inches	1½	2	2½	3
Height, inches	3	4	5	7
Each	$0.15	.20	.25	.30

31–250 **CYLINDERS or HYDROMETER JARS** for use where a tall jar of small diameter is desired. Of clear white glass with foot and rim.

	a	b	c	d	e
Size, inches	12 × 1 ½	12 × 2	15 × 2	15 × 3	18 × 3
Each	$0.50	.55	.80	1.00	1.35

5095 **CYLINDERS, GRADUATED,** of glass, broad base, with lip, graduated in cubic centimeters.

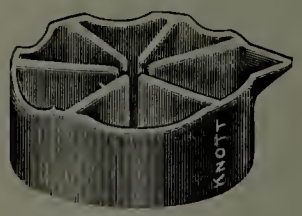
	a	b	c	d	e	f	g
Capacity, cc.	10	25	50	100	250	500	1000
Each	$0.30	.36	.40	.52	.90	1.10	1.85

5096 **CYLINDERS, GRADUATED, double graduations,** reading up and down, of glass, broad base, with lip. Graduated in cubic centimeters.

	a	b	c	d	e	f
Capacity, cc.	25	50	100	250	500	1000
Each	$0.38	.45	.56	.95	1.20	2.00

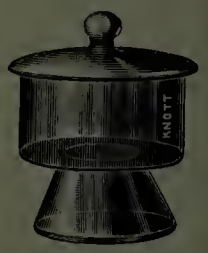
5098 **CYLINDERS, MIXING, GRADUATED AND STOPPERED,** serviceable when making standard solutions. Of glass, broad base, round glass stoppers, graduated in cubic centimeters.

	a	b	c	d	e	f	g
Capacity, cc.	25	50	100	200	250	500	1000
Each	$0.75	.85	.95	1.20	1.30	1.85	2.25



No. 5115

No. 5116



No. 5118

DEFLAGRATING SPOONS. See SPOONS, DEFLAGRATING, Page 479.

5115 **DESSICATOR or ACID DISH, PORCELAIN,** for use with acid in dessicators **$0.85**

5116 **DESSICATOR, HARCOURT.** Consists of ground glass plate, bell glass and acid dish as illustrated. Set **2.45**

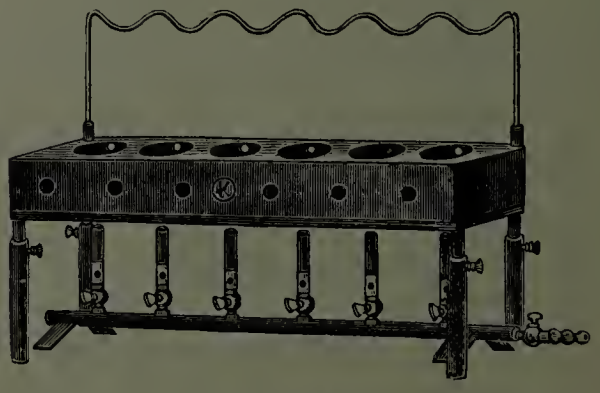
5118 **DESSICATORS, SCHEIBLER'S,** of glass, with covers ground air-tight.

	a	b
Diameter, inches	4	6
Each	**$0.75**	**1.15**

5120 **DESSICATOR PLATES, glazed,** on three small feet, for use in Scheibler's Dessicators.

	a	b
Diameter, mm.	95	140
No. of Holes	3	5
Each	**$0.80**	**1.10**

5122 **DIAMOND** for writing on glass. Excellent quality **5.40**



No. 5125

5125 **DIGESTING SHELF, KJELDAHL'S, oblong form of sheet iron,** with rod to support the flasks. The shelf is supported on adjustable legs. Size 24 inches long, 5½ inches wide, 9½ inches high. Complete with six burners, each with stopcock **$17.00**

5127 **DIGESTING SHELF, ELECTRICALLY HEATED, KJELDAHL'S, oblong form of sheet iron,** with rod to support the flasks. Each heater, 3½ inches in diameter, is a unit, and either one or all may be used at one time, as desired. Size 24 inches long, 5½ inches wide, 9 inches high. With six heaters **44.00**

5134 **DISHES, AGATE WARE.**

	a	b	c
Dimensions, inches	6⅛ × 1½	7 × 1⅝	8½ × 2
Capacity, quarts	½	1	2
Each	**$0.16**	**.18**	**.22**

5136 **DISHES, CRYSTALLIZING.** Of clear white glass, flat bottoms, straight sides.

	a	b	c
Diameter, inches	2	3	4
Each	**$0.18**	**.24**	**.32**

No. 5136

EVAPORATING DISHES

5139 DISHES, EVAPORATING, PURE SHEET NICKEL, with lip, polished.

	a	b	c
Diameter, inches	2	2¾	3½
Capacity, cc.	40	100	200
Each	**$0.90**	**1.30**	**1.90**

5141 DISHES, EVAPORATING, PORCELAIN, excellent quality, well adapted to general chemical work in the laboratory. Thin, uniform, glazed inside and outside.

	a	b	c	d	e	f	g	h	i	j	k	l
Size, No.	00	0	1	2	3	4	5	6	7	8	9	10
Diameter, cm.	7	8	8½	9	10	11	12	14½	18	21½	26½	31
Capacity, cc.	65	85	110	140	165	250	290	475	810	1320	2585	4000
Each	**$0.15**	**.20**	**.25**	**.35**	**.40**	**.45**	**.55**	**.70**	**.90**	**1.20**	**1.75**	**2.75**

5142 DISHES, EVAPORATING, ROYAL WORCESTER PORCELAIN. (See index, **"Royal Worcester Porcelain Ware,"** for characteristics.) Glazed inside and outside, with spout.

	a	b	c	d	e	f	g	h	i	j
Size No.	00	0	1	2	3	4	5	6	7	8
Diameter, outside, mm.	70	80	85	90	100	110	120	145	185	215
Height, mm.	27	30	33	37	42	43	50	48	54	63
Capacity, cc.	60	80	100	140	175	210	300	385	765	1285
Each	**$0.33**	**.39**	**.48**	**.60**	**.75**	**.84**	**.96**	**1.35**	**1.80**	**2.16**

5145 DISHES, EVAPORATING, FUSED SILICA. (See index, **"Fused Silica Ware,"** for characteristics.) Glazed. Measurements given are inside measurements.

	a	b	c	d	e	f
Diameter, inches	2	2¾	3¼	3½	3⅞	4¼
Depth, inches	13/16	1	1 3/16	7/8	1 3/16	1¾
Diameter, mm.	51	.70	82	89	98	108
Depth, mm.	21	25	30	22	30	44
Each	**$1.00**	**1.15**	**1.25**	**1.35**	**1.60**	**1.85**

5146 DISHES, EVAPORATING, FUSED SILICA. (See index, **"Fused Silica Ware,"** for characteristics.)

Unglazed.	a	b	c	d	e	f	g	h	i	j	k	l	m	n
Diameter, inches	5⅜	5⅛	6	6	7	7	8	8	9	9	12¼	15½	18	18
Depth, inches	2¼	2½	2½	3	2¾	3¾	3¼	4¼	3½	4¾	5¼	4	7	8½
Diameter, mm.	137	130	152	152	178	178	203	203	229	229	311	394	458	458
Depth, mm.	57	63	63	76	70	95	82	108	89	120	133	102	178	216
Each	**$2.85**	**3.00**	**3.15**	**3.50**	**3.75**	**3.90**	**4.35**	**5.00**	**6.00**	**6.75**	**10.00**	**12.00**	**14.00**	**15.00**

No. 5148

No. 5150

5148 **DISHES, FILTER, ALUNDUM.** (See index, "Alundum Ware," for characteristics.) Porosity 40.7 per cent. carried in stock. Porosities of 36.9 per cent. and 47.4 per cent. can be obtained at same prices.

	a	b	c
Dimensions, inches	2½ × 1	4 × 2	5⅝ × 2
Capacity, cc.	50	300	400
Each	$0.44	1.10	1.65

5150 **DISH, INCINERATING, ALUNDUM.** (See index "Alundum Ware," for characteristics.) Rectangular form.

	a	b	c
Dimensions, inches	4⅝ × 4⅝ × 1	9¾ × 4 × ¾	12⅜ × 6⅜ × 2⅜
Each	$1.65	2.50	5.50

5151 ——, round form, 2¾ inches diameter, ⅝ inch deep $0.55

No. 5155

No. 5157

No. 5159

No. 5167

No. 5169a-c

No. 5169d

5154 **DISHES, LEAD,** of heavy sheet lead.

	a	b	c
Diameter, inches	2	3	4
Each	$0.12	.20	.32

5155 **DISH, LEAD, rectangular,** for etching $0.20

5157 **DISHES, MILK, ALUMINUM,** flat bottom, straight sides.

	a	b	c
Diameter, inches	2	3	4
Each	$0.21	.33	.50

5159 **DISHES, PETRI or DOUBLE,** glass cover, diameter 10 centimeters 28

5161 **DISHES, PETRI or DOUBLE, porous porcelain cover,** according to Boston Board of Health. Diameter 10 centimeters 30

No. 5165

5165 **DISHES, FUSED SILICA.** (See index, **"Fused Silica Ware,"** for characteristics.) Flat, with lip, glazed.

	a	b	c	d
Diameter, mm.	63	73	95	124
Depth, mm.	13	13	18	21
Each	$1.15	1.25	1.35	1.85

5167 **DISH, STAINING,** with cover, for staining slide sections $0.75

5169 **DISHES, STENDER or PREPARATION,** of clear white glass, covers grooved and ground on.

	a	b	c	d
Diameter, inches	1⅜	2	2⅜	3⅜
Height, inches	¾	1	1⅛	3½
Each	$0.12	.15	.22	.25

DISSECTING INSTRUMENTS

No. 5181

No. 5196

No. 5190

No. 5182

No. 5184

No. 5186

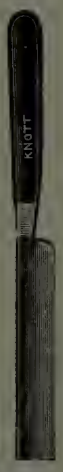
No. 5188

No. 5192

No. 5194

No. 5201

No. 5208



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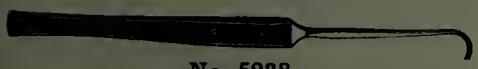
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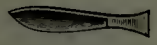
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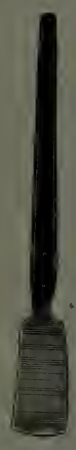
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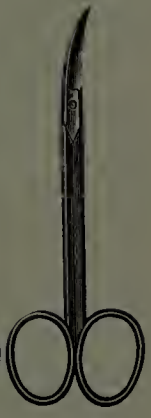

No. 5227

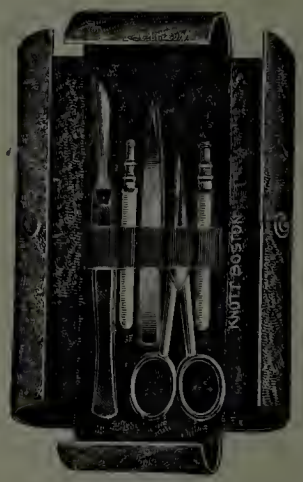
5180	**BLOWPIPE, 2½ inches, for inflating arteries,** etc.	$0.15
5181	**DISSECTING PAN, BUSSEY'S,** 7½ × 11 inches, with black wax	.48
5182	**FORCEPS, steel, 5-inch,** nickel-plated, straight, heavy corrugated points, corrugated handles	.45
5184	**FORCEPS, FINE, STRAIGHT, steel, 4-inch,** nickel-plated, corrugated points, corrugated handle, with guide pin	.45
5186	**FORCEPS, FINE, CURVED, steel, 4-inch,** nickel-plated, corrugated points, corrugated handle, with guide pins	.50
5188	**FORCEPS, FINE POINTS,** plain, **4¼-inch,** smooth handles	.15
5190	**FORCEPS, BONE-CUTTING, 5½-inch,** strong, accurately made, knife shaped blades. With lock	1.15
5192	**FORCEPS, COVER-GLASS, STEWART'S, 4½-inch,** nickel-plated steel wire	.15
5194	**FORCEPS, COVER-GLASS, NOVY'S, WITH LOCK, 4½-inch.** The thin edge of the lower blade enables one to pick up a cover glass readily. The curving pointed blade prevents capillary drainage	1.25
5196	**HOOKS AND CHAINS,** triple hooks and connecting chains, nickel-plated	.18
5198	**NEEDLES, STRAIGHT, wood handle** Per Dozen	.30
5199	**NEEDLES, BENT, wood handle** Per Dozen	.30
5201	**NEEDLE HOLDER, bone handle** with **clamping holder** for straight or bent needles, 3½-inch	.10
5203	**NEEDLES, STRAIGHT,** for use with above holder Per Dozen	.10
5204	**NEEDLES, BENT,** for use with above holder Per Dozen	.10
5208	**RAZOR, SECTION,** folding handle, superior quality, 3-inch blade, one side flat, straight edge	1.10
5210	**RAZOR, SECTION,** straight handle, finest steel, 3-inch blade, one side flat, straight edge	1.85
5214	**SAW, BONE,** superior grade, 4 inches long	1.75
5216	**SCALPEL,** 1¾-inch blade, excellent quality steel, ebony handles riveted to the blade	.40
5217	——, 1¼ inch blade	.40
5218	——, 1-inch blade	.40
5220	**SCALPEL, CARTILAGE (Cartilage Knife),** 6½-inch, all steel; blade 2 inches long; corrugated handle	.65
5224	**SCISSORS, 4½ inch, medium heavy,** straight, fine cutting points	.48
5226	**SCISSORS, 4½ inch, fine sharp straight points;** heavy pattern	.65
5227	**SCISSORS, 4½-inch, fine sharp curved points;** heavy pattern	.65
5230	**SECTION LIFTER,** thin flexible blade, 1¾ × ⅜ inches, ebony handle riveted to blade	.30
5232	——, blade 1¾ × ¾ inches	.35
5234	——, blade 2 × 1⅛ inches	.40
5238	**TENACULUM,** steel shank with sharp hook, ebony handle riveted to blade	.35
5240	**TENACULUM AND NEEDLE,** solid steel, sharp hook, sharp point	.40

DISSECTING SETS

Our sets of dissecting instruments have been made up with great care. The instruments are of finely tempered steel and the shapes and sizes chosen for the various sets have met with complete approval of teachers of the natural sciences.

The cases are of the folding pocket form with separate loops for each instrument. The **leatherette cases** are strong and durable. They are lined with cloth, with cloth flaps. The **leather cases** are made of black morocco and are lined with leather with chamois flaps to protect the instruments.

No. 5255



No. 5257

No. 5259

No. 5261

No. 5263

5255 HARCOURT FIRST YEAR STUDENTS' DISSECTING SET, one fold leatherette case containing Ruler and six high-grade instruments as follows: — 2 Dissecting Needles, Forceps, Scissors, Scalpel and Pipette . . . . . Set **$1.20**

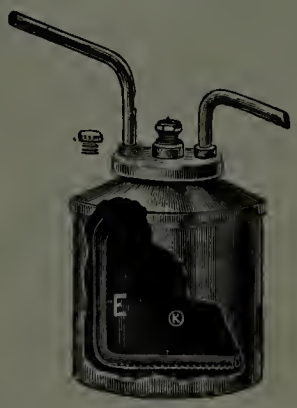
5257 HARCOURT ADVANCED STUDENTS' DISSECTING SET, one fold leatherette case containing five high grade instruments, — 2 Bone-handle Clamping Needle Holders with needle for each, Forceps, Scissors and Scalpel . . . . . Set **1.25**

5259 HARCOURT SUPERIOR DISSECTING SET, two fold leatherette case containing, — Cartilage Knife, Scalpel, Tenaculum, Forceps, Blowpipe, Scissors and Hooks and Chains . . . . . Set **2.65**

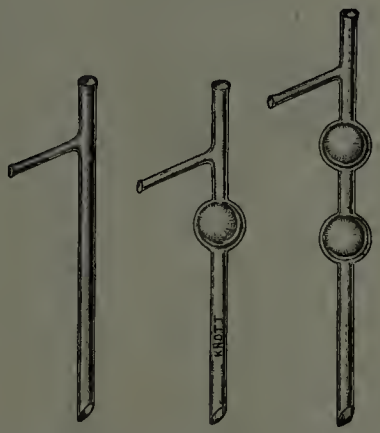
5261 THE UNIVERSITY DISSECTING SET, — morocco leather case, leather lined, chamois flaps, containing the following extra fine grade instruments, — two Bone-handle Clamping Needle Holders, each with needle, Fine-pointed Curved Forceps, Fine-pointed Scissors, Medium Scissors, Blowpipe, Hooks and Chains, Tenaculum, Heavy Forceps and three sizes of Scalpels. Twelve instruments in case . . . . . Set **3.00**

5263 HARCOURT RESEARCH DISSECTING SET, leatherette covered case with clasp, containing the following extra fine grade instruments, — Cartilage Knife, four sizes of Scalpels, Tenaculum, Forceps, Hooks and Chains, Blowpipe, Scissors and Bone Saw. Eleven instruments in case. Set **5.75**

No. 5275



No. 5277



No. 5285 No. 5285A No. 5285B

5275 **DISTILLING APPARATUS, HEAVY POLISHED COPPER,** for destructive distillation of heavy oils and other liquids or solids requiring a high heat. The distillation may be made by live steam or by direct heat with or without agitation by hot air blown through, as desired. Capacity ½ gallon **$18.50**

5277 **DISTILLING APPARATUS, SALLERTON'S, POLISHED COPPER,** for determining percentage of alcohol in wine, beer, cider, etc. Capacity ½ pint **9.75**

5415 **DISTILLATION FLASKS, FRACTIONAL,** with side tubes. (For illustration, see page **438**)

	a	b	c	d	e	f
Capacity, cc.	15	30	100	250	500	1000
Each	**$0.20**	**.25**	**.45**	**.60**	**.75**	**.95**

5285 **DISTILLATION TUBE, FRACTIONAL.** Plain, with side tube **$0.26**

5285A ——, with one bulb . . . . . **.44**

5285B ——, with two bulbs . . . . . **.55**

DRYING OVENS

These ovens are of polished copper, with tubulations for thermometer and gas regulator. Extra sheet iron bottom, single and double wall, as listed below.

No. 5295

No. 5299

5295 **DRYING OVEN, single wall,** on iron stand 8 inches high, with set screw by which oven is held firmly. Inside dimensions, 6 × 8 × 6 inches deep. With one removable shelf **$5.50**

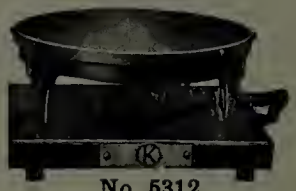
5297 **DRYING OVEN, double wall,** otherwise same as above. With one removable shelf **7.75**

5299 **DRYING OVEN, double wall,** same as No. **5297,** but with the addition of **water bath top.** With one removable shelf **9.75**

5301 **DRYING OVEN, double wall,** same as No. **5297,** but inside dimensions 8 × 10 × 8 inches high. With one removable shelf **11.75**

DRYING PAPER. See page **472.**

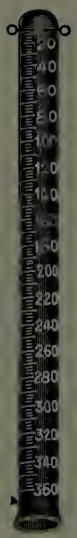
No. 5310



No. 5312

No. 5316

No. 5314



No. 5325

No. 5332

No. 5344

No. 5330

5310 **ELECTRIC IRON** with "Inverted Rack," enabling the iron to be used as a stove when so desired. Size, 3⅝ × 7 inches, weight 5 pounds. Consumption 475 watts on 120 volts either D. C. or A. C. With 6 feet cord and lamp socket plug **$3.90**

5312 **ELECTRIC STOVE, PORTABLE,** 4½ inches diameter, for use on either D. C. or A. C. circuits of 120 volts. Consumption 250 watts; mounted on enamel slate base. With 6 feet cord and plug for attaching lamp socket **4.75**

5314 **ELECTRIC SOLDERING IRON,** 14 ounce, ⅞ × 11 inches, for use on either D. C. or A. C. circuits of 120 volts. Consumption 75 watts. With cord and plug **6.80**

5316 **ELECTRIC PORTABLE WATER HEATER,** of copper, nickel-plated. Capacity one pint. For use on either D. C. or A. C. circuits of 110 volts. Consumption 400 watts. With 6 feet of cord . . . **5.75**

ELECTROLYSIS APPARATUS. See Index.

5325 **EUDIOMETERS, BUNSEN'S,** with platinum electrodes, graduated to ⅕ cc.

	a	b
Capacity, cc.	50	100
Each	**$2.70**	**3.40**

EVAPORATING DISHES. See **DISHES, EVAPORATING.**

3830 **EXPANDER, TUBE AND BULB,** for stretching necks of rubber bulbs and tubes. For illustration see Page **419** . . . . . **.50**

5330 **EXTRACTION APPARATUS, SOXHLET'S.** Complete with flask, extractor and condenser.

	a	b	c
	Small	Medium	Large
Each	**$2.75**	**3.00**	**3.75**

5332 **EXTRACTION APPARATUS, SOXHLET'S.** The **Water Bath** is made of heavy **polished copper,** tinned inside. 23 inches long, 4 inches deep and 4½ inches wide, with six holes 2½ inches in diameter, on legs 7 inches high. Extreme height, including rods, is 31 inches. Rack adjustable **24.25**

5335 **EXTRACTION CARTRIDGES.** Seamless, of fat-free paper. May be used repeatedly. Per package **3.50**

EXTRACTION FLASKS. See **FLASKS,** Page **438.**

5342 **EXTRACTION THIMBLES, ALUNDUM.** (See index, **"Alundum Ware,"** for characteristics.) Alundum thimbles are preferable to paper thimbles in that they remain constant in weight and may be used an indefinite number of times and permit the ignition of the extracted residue without removing the residue from the thimble. Thickness of wall, about one mm.

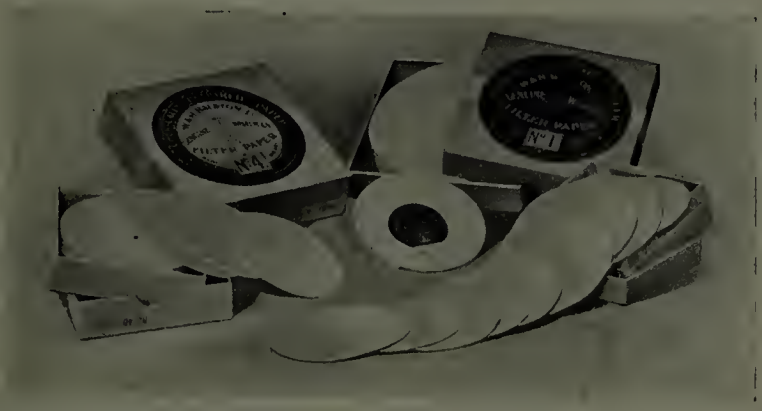
Three degrees of porosity may be obtained, — 36.9 per cent. — 40.7 per cent. and 47.4 per cent. We carry in stock, however, only 40.7 per cent.

	a	b	c	d	e	f	g
Outside diameter, mm.	6	19	25	30	34	35	45
Height, mm.	31	90	70	80	100	55	127
Round Bottom, each	**$0.30**				**.70**		**1.15**
Flat Bottom, each		**.60**	**.48**	**.50**		**.60**	

5344 **EXTRACTION TUBES, SOXHLET'S.**

	a	b	c
	Small	Medium	Large
Each	**$1.75**	**2.10**	**2.40**

FAUCETS, WATER. See Page **9.**



5350 **FILE, ROUND, rat-tail,** good quality, 5 inches long **$0.15**
5351 **FILE, TRIANGULAR, glass cutting,** good quality, 5 inches long . . . . . **.15**
5355 **FILTER CONES, ALUNDUM,** for use with the ordinary 60 degree funnel to which it is held firmly by stretching a rubber gasket over the top of the funnel before introducing the cone. Light aluminum stands are supplied, without extra charge, with the cones for supporting them on the balance pan. Three degrees of porosity may be obtained, — 36.9 per cent., 40.7 per cent. and 47.4 per cent. Our stock, however, contains Filter Cones 40.7 per cent. only.

	a	b	c	d
Diameter, inches	1¾	2½	3	4½
Height, inches	1 5/16	1 7/8	2 7/16	3½
Capacity, cc.	20	50	60	100
Each	**$0.33**	**.39**	**.45**	**.56**

5356A **RUBBER GASKETS** for use with above Filter Cones in making the proper connections with the funnels. For use with Nos. **5355** a and **b** . . . . . **.08**
5356B ——, for use with No. **5355c** . . . . . **.12**
5356C ——, for use with No. **5355d** . . . . . **.15**
FILTER DISCS. See **PLATES, FILTER,** Page **472.**

We carry in stock two lines of **FILTER PAPER,** — the **HARCOURT FILTER PAPER** for general laboratory use in qualitative work and the **WHATMAN FILTER PAPER** selected with extreme care for different kinds of quantitative work.

5365 **FILTER PAPER, HARCOURT, round,** a pure white paper of exceptional quality, of tough texture and very rapid. This grade of paper is suggested for general use in the laboratory and for all qualitative work.

	a	b	c	d	e	f
Diameter, inches	3	4	5	6	8	10
Per Box of 100 Papers	**$0.09**	**.15**	**.18**	**.20**	**.30**	**.45**

5366 ——, **in sheets,** same quality as above. Sheets 19 × 19 inches . . . . Per Quire **$0.38**; Per Ream **$6.60**

Few, if any, manufacturers have devoted so much attention during the past twenty years to the chemical problems pertaining to the manufacture of high grade papers as the Whatman Paper Company. We are now able to offer their high grade line of filter papers which we are able to guarantee to be of the very highest quality.
Please note the low percentage of ash in the various sizes given below.

5370 **WHATMAN NO. 1 FILTER PAPER** for general quantitative and qualitative work. The paper is tasteless and free from chlorine and starch. Retains barium sulphate when properly precipitated.

	a	b	c	d
Diameter, cm.	9	11	12½	15
Ash per Circle, gram	.00076	.0017	.0016	.0021
Price per 100	**$0.19**	**.22**	**.24**	**.34**

5371 ——, **in sheets,** same quality as above. Sheets 18¼ × 22½ inches . . . . . Per C **$3.24**
5372 **WHATMAN NO. 4 FILTER PAPER** for filtering fruit juices, syrups, oils, varnishes, etc.

	a	b	c	d	e
Diameter, cm.	11	12½	15	18½	32
Price per 100	**$0.34**	**.36**	**.46**	**.58**	**1.44**

5373 ——, **in sheets,** same quality as above. Sheets 18½ × 22½ inches . . . . . Per C **5.04**
5374 **WHATMAN NO. 30 FILTER PAPER** for quantitative work. This paper has low ash and close texture. Treated by hydrochloric acid to remove such chemical salts as are normally contained in the fibre.

	a	b	c	d
Diameter, cm.	9	11	12½	15
Ash per Circle, gram	.00056	.00089	.00108	.00159
Price per 100	**$0.60**	**.75**	**.95**	**1.25**

5376 **WHATMAN NO. 40 "ASHLESS" FILTER PAPER** for quantitative work in which a high degree of accuracy is desirable. This paper being pure, gives a very low ash and being close in texture, will retain even the finest precipitates. Subjected to a combined treatment of hydrochloric and hydrofluoric acid, it is lower in ash than No. **30** above, the hydrochloric acid having the effect of removing traces of silicious matter.

	a	b	c	d
Diameter, cm.	9	11	12½	15
Ash per Circle, gram	.00016	.00024	.00030	.00043
Price per 100	**$1.08**	**1.32**	**1.44**	**1.68**

5385 **FILTER PLATES, WITTE'S, PORCELAIN.** Diameter 1½ inches . . . . . **.35**
5386 ——, diameter 2½ inches . . . . . **.40**

5405 FLASKS, FLAT BOTTOM.

	a	b	c	d	e	f	g	h
Capacity, cc.	25	50	100	250	500	1000	2000	4000
Each	$0.07	.08	.10	.14	.20	.30	.50	1.10

5407 FLASKS, FLAT BOTTOM, "PYREX." (See index, "Pyrex Glassware," for characteristics.)

	a	b	c	d	e	f	g	h	i	j	k	l
Capacity, cc.	50	100	150	200	300	400	500	700	1000	1500	2000	3000
Takes Stopper No.	K11	K11	K13	K15	K21	K21	K25	K28	K30	K30	K33	K37
Each	$0.12	.13	.16	.18	.21	.26	.29	.36	.43	.51	.60	.76

5408 FLASKS, RING NECK, FLAT BOTTOM, "PYREX GLASS."

	a	b	c	d
Capacity, cc.	500	700	1000	2000
Takes Stopper No.	K28	K28	K30	K37
Each	$0.38	.47	.55	.78

5409 FLASKS, FLAT BOTTOM, "FUSED SILICA." (See index, "Fused Silica Ware," for characteristics.)

Spherical shape.

	a	b	c	d	e	f	g
Capacity, cc.	50	100	150	200	250	500	1000
Each	$2.75	4.00	4.25	5.00	6.25	7.50	16.00

5411 FLASKS, ROUND BOTTOM, spherical.

	a	b	c	d
Capacity, cc.	100	250	500	1000
Each	$0.10	.14	.20	.30

5413 FLASKS, ROUND BOTTOM, "FUSED SILICA." (See index, "Fused Silica Ware," for characteristics.)

	a	b	c	d	e	f	g
Capacity, cc.	50	100	150	200	250	500	1000
Each	$2.75	4.00	4.25	5.00	6.25	7.50	16.00

5415 FLASKS, FRACTIONAL DISTILLATION, with side tubes.

	a	b	c	d	e	f
Capacity, cc.	15	30	100	250	500	1000
Each	$0.20	.25	.45	.60	.75	.95

5417 FLASKS, DISTILLATION, "FUSED SILICA." (See index, "Fused Silica Ware," for characteristics.)

Spherical, with side arm.

	a	b	c	d	e	f	g
Capacity, cc.	50	100	150	200	250	500	1000
Each	$3.25	4.75	5.00	6.00	7.50	9.00	18.50

5419 FLASKS, ERLENMEYER.

	a	b	c	d	e
Capacity, cc.	60	125	250	500	1000
Each	$0.10	.12	.14	.18	.30

5421 FLASKS, ERLENMEYER, "PYREX GLASS." (See index, "Pyrex Glassware," for characteristics.)

	a	b	c	d	e	f	g	h	i	j	k	l
Capacity, cc.	50	100	150	200	250	300	500	600	750	1000	1500	2000
Takes Stopper No.	K11	K17	K19	K23	K23	K25	K25	K25	K30	K33	K37	K43
Each	$0.11	.12	.13	.15	.17	.19	.27	.29	.33	.42	.51	.60

5423 FLASK, ERLENMEYER, WIDE MOUTH, "PYREX GLASS." Greatest diameter 2 3/16 inches, height 6 7/8 inches, diameter of mouth 2 inches; takes rubber stopper K47. Capacity 500 cc $0.27

5425 FLASKS, EXTRACTION, SOXHLET'S, large mouth.

	a	b	c	d	e
Capacity, cc.	60	100	250	500	1000
Each	$0.15	.20	.30	.40	.50

5427 FLASK, EXTRACTION, "PYREX." Round bottom, capacity 100 cc. Height 3 7/8 inches, diameter 2 3/8 inches, diameter of neck 1 5/32 inches $0.15

5429 FLASK, EXTRACTION, "PYREX." Round bottom, capacity 2000 cc. Height 9 11/16 inches, diameter 6 7/16 inches, diameter of neck 2 23/32 inches 69

5430 FLASKS, FILTERING, conical form with side neck, heavy glass, uniform.

	a	b
Capacity, cc.	250	500
Each	$0.30	.45

5431 FLASK, KJELDAHL or DIGESTION, for nitrogen determinations. Capacity 200 cubic centimeters $0.22

5433 FLASKS, KJELDAHL or DIGESTION, "PYREX." (See index, "Pyrex Glassware," for characteristics.) Round bottom, long neck.

	a	b	c
Capacity, cc.	300	500	800
Each	$0.28	.37	.45

No. 5435 No. 5437

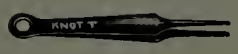
No. 5464

No. 5466

No. 5468

No. 5450 No. 5457 No. 5459 No. 5460 No. 5462

No. 5-270 No. 5-272


No. 5445

Nos. 5472 and 5472A

5435 FLASKS, VOLUMETRIC, without glass stopper, graduated with one and two marks as follows:

	a	b	c	d	e	f	g	h	i	j	k	l	m
Capacity, cc.	5	10	20	25	50	50 & 55	100	100 & 110	200	200 & 220	250	500	1000
Each	$0.15	.20	.25	.30	.35	.40	.45	.48	.50	.55	.60	.80	.95

5437 FLASKS, VOLUMETRIC, with glass stopper, graduated as follows.

	a	b	c	d	e	f	g
Capacity, cc.	25	50	100	200	250	500	1000
Each	$0.50	.60	.70	.75	.80	.95	1.35

5-270 FLUSH PLATE, nickel-plated, for inserting in any table flush with the top surface. When fitted to a table and screwed into place, it offers an excellent socket for a support rod for funnel and filter rings, clamps, etc. Tapped ¼ × 20 for 10 mm. rods $0.35

5-272 ——, tapped ⅜ × 16 for 13 mm. rods 45

SUPPORT RODS. See page 10.

5445 FORCEPS, STEEL, 5-inch, for handling phosphorous, potassium, etc. 10

5450 FUNNELS, BUNSEN'S, stem cut at an angle of 60°.

	a	b	c	d	e	f	g	h
Diameter, inches	2	2½	3	4	5	6	8	10
Each	$0.15	.18	.20	.25	.35	.45	.75	1.50

3865 FUNNELS, BURETTE (For illustration see Page 419) . . . . . Each .15

5457 FUNNELS, SEPARATORY, cylindrical.

	a	b	c
Capacity, cc.	30	60	125
Each	$1.20	1.45	1.90

5459 FUNNELS, SEPARATORY, globe shape.

	a	b	c	d	e
Capacity, cc.	60	125	250	500	1000
Each	$1.45	1.95	2.35	2.80	3.90

5460 FUNNELS, SEPARATORY, SQUIBB'S, pear shape, with glass stopper.

	a	b	c
Capacity, cc.	125	250	500
Each	$2.35	3.40	4.30

5462 FUNNEL, GRADUATED, SEPARATORY, CYLINDRICAL. Long stem, capacity 250 cc. $4.25

5464 FUNNEL, POLISHED COPPER, DOUBLE WALL, for hot filtrations 4.85

5466 FUNNEL, KOCH'S, POLISHED COPPER, single wall for hot filtrations. With legs 3.70

5468 ——, double wall for hot filtrations. With legs 5.75

5470 FUNNEL, PORCELAIN, small perforations, for use in rapid filtrations, diameter 4¼ inches 70

5470A ——, diameter 5¼ inches 90

5472 FUNNEL, BUCHNER, PORCELAIN, with fixed perforated porcelain plate, diameter 80 millimeters .90

5472A ——, diameter 100 millimeters 1.30

No. 5477

No. 5479

Furnace Open Ready for the Introduction of a Tube

No. 5480

Nos. 5482 and 5484

3885 **FURNACE, COMBUSTION,** four burners with air regulators, stopcocks, and wing tops. With support and trough for heating tubes. Complete as illustrated, Page **420** **$9.25**

5477 **FURNACE, CRUCIBLE,** for **illuminating gas.** Consists of a simple pot for holding the crucible, with a lid and a blowpipe all mounted on a suitable cast iron base. Takes No. **00** Clay or Lead Crucibles. Clay parts, outside, measure $4\frac{1}{2} \times 5\frac{3}{8}$ inches high. Pot, inside, measures $2\frac{5}{8}$ inches $\times$ $2\frac{1}{2}$ inches deep. Furnace on stand is $6\frac{1}{2}$ inches high over all.

Without Foot Blower, but complete with No. **00** Clay Crucible **3.50**

5478 **FURNACE, CRUCIBLE,** similar to above but with **Injector Gas Burner.** Operates with illuminating gas, natural gas or gasoline gas. Takes No. **00** Clay or Lead Crucibles. Clay parts, outside, measure $4\frac{1}{8}$ inches $\times$ $5\frac{3}{8}$ inches high. Pot inside, measures $2\frac{5}{8}$ inches $\times$ $2\frac{1}{2}$ inches deep. Furnace on stand is $6\frac{1}{2}$ inches high over all.

Without Foot Blower, but complete with one No. **00** Clay Crucible **4.50**

5479 **FURNACE, CRUCIBLE AND MUFFLE.** Operates with illuminating gas, natural gas or gasoline gas. Takes muffle $3\frac{1}{2} \times 2\frac{7}{8} \times 6\frac{1}{4}$ inches and No. **3** Clay or Lead Crucible ($3\frac{3}{4}$ inches diameter $\times$ 4 inches high). Pot and cover, outside, measures $9\frac{1}{2}$ inches $\times$ 11 inches high; inside, $6\frac{1}{2}$ inches deep $\times$ 6 inches diameter.

Without Blower, but complete with Muffle and Clay Crucible **12.50**

5479A **PLUMBAGO MUFFLE,** $3\frac{1}{2} \times 2\frac{7}{8} \times 6\frac{1}{4}$ inches **1.90**

5480 **FURNACES, TUBE for combustions.** Using the ordinary foot blower, this furnace will heat an iron tube $\frac{3}{4}$ to 1 inch in diameter, to its softening point in ten minutes. Without the blast it will heat the same tube to redness. Can be used with natural gas, coal gas or gasoline gas.

	a	b	c
For tubes of length, inches	12	18	24
Each	**$12.75**	**15.25**	**19.50**

5482 **FURNACES, ELECTRIC, CRUCIBLE,** for work up to 1000° C. (1832° F.). Operates on 110 or 220 Volt A. C. or D. C. The heating element of "Chromel" wire is wound on an alundum core, surrounded by a packing of special heat insulating material, enclosed in a sheet iron case. The maximum working capacity is 1000° C. (1832° F.) and by means of a controlling rheostat should be kept within this limit.

With wire stand for using in a horizontal position, but without Controlling Rheostat.

	a	b	c
Chamber, Diameter, inches	2	4	5
Chamber, Depth, inches	$2\frac{1}{2}$	4	5
Current Consumption, watts	300	900	1100
Each	**$20.00**	**44.50**	**66.75**

5484 **FURNACES, ELECTRIC CRUCIBLE,** same as above, complete with wire stand for using in a horizontal position and with Controlling Rheostat.

	a	b	c
Chamber, Diameter, inches	2	4	5
Chamber, Depth, inches	$2\frac{1}{2}$	4	5
Current Consumption, watts	300	900	1100
Each	**$25.50**	**54.00**	**76.00**

REPAIR PARTS. PRICES ON APPLICATION.

Nos. 5494 and 5496

Nos. 5510 to 5513

5494 **FURNACES, ELECTRIC MUFFLE,** for work up to 1000° C. (1832° F.). Operates on 110 or 220 Volts A. C. or D. C.

The heating unit of "Chromel" wire is wound on an alundum muffle surrounded by a packing of special heat insulating material, enclosed in a sheet iron case. The maximum working capacity is 1000° C. (1832° F.) and by means of a controlling rheostat, should be kept within this limit.

Without Controlling Rheostat	a	b	c	d
Chamber, Length, inches	5	8	9	11
Chamber, Width, inches	3⅛	4¼	5¼	7½
Chamber, Height, inches	2½	3	3¾	5¼
Current Consumption, watts	650	1100	1800	3300
Price, 110 or 220 Volts, A. C. or D. C.	**$44.50**	**56.00**	**72.50**	**100.00**

NOTE:—When ordering, specify Line Voltage and whether A. C. or D. C.

5496 **FURNACES, ELECTRIC MUFFLE,** same as above, with Controlling Rheostat.

	a	b	c	d
Chamber, Length, inches	5	8	9	11
Chamber, Width, inches	3⅛	4¼	5¼	7½
Chamber, Height, inches	2½	3	3¾	5¼
Current Consumption, watts	650	1100	1800	3300
Price, 110 or 220 Volts, A. C. (60 Cycle) or D. C.	**$52.25**	**66.00**	**85.75**	**122.50**

NOTE:—When ordering, specify Line Voltage, and whether A. C. or D. C.

REPAIR PARTS AND CHARGES

Immediate renewals can be made easily with the repair parts listed below.

5500	**ALUNDUM MUFFLE** for Furnace Nos. **5494a** and **5496a**		**$2.75**
5500A	——, wound, ready for use		**10.00**
5501	**ALUNDUM MUFFLE** for Furnace Nos. **5494b** and **5496b**		**4.50**
5501A	——, wound, ready for use		**15.00**
5502	**ALUNDUM MUFFLE** for Furnace Nos. **5494c** and **5496c**		**5.75**
5502A	——, wound ready for use		**20.00**
5503	**ALUNDUM MUFFLE** for Furnace Nos. **5494d** and **5496d**		**7.75**
5503A	——, wound ready for use		**31.50**
5504	**CHROMEL WIRE** for Furnace Nos. **5494a** and **5496a**	Lot	**2.75**
5505	——, for Furnace Nos. **5494b** and **5496b**	Lot	**4.50**
5506	——, for Furnace Nos. **5494c** and **5496c**	Lot	**6.75**
5507	——, for Furnace Nos. **5494d** and **5496d**	Lot	**11.25**

5510 **FURNACE, ELECTRIC TUBE,** for work up to 1000° C. (1832° F.). Operates on 110 or 220 Volts A. C. or D. C.

The heating unit of "Chromel" wire is wound on an alundum tube, surrounded by a packing of special heat insulating material, enclosed in a sheet iron case. The maximum working capacity is 1000° C. (1832° F.) and, by means of a controlling rheostat, should be kept within this limit. Chamber 1⅛ inches diameter by 12 inches long. Current consumption 500 watts. Without Controlling Rheostat **27.75**

5511	——, chamber 1¼ inches diameter by 12 inches long. Current consumption 500 watts		**27.75**
5512	**FURNACE, ELECTRIC TUBE,** same as No. **5510** but with Controlling Rheostat		**36.00**
5513	——, same as No. **5511**, but with Controlling Rheostat		**36.00**

REPAIR PARTS AND CHARGES

Immediate renewals can be made easily with the repair parts listed below.

5515	**ALUNDUM TUBE** for Furnace Nos. **5510** and **5512**		**2.35**
5515A	——, wound ready for use		**7.75**
5516	**ALUNDUM TUBE** for Furnace Nos. **5511** and **5513**		**2.50**
5516A	——, wound ready for use		**7.75**
5517	**CHROMEL WIRE** for Furnace Nos. **5510** and **5512**	Lot	**2.25**
5518	——, for Furnace Nos. **5511** and **5513**	Lot	**2.25**

Nos. 5520 and 5522

Nos. 5530 to 5537

5520 **FURNACES, ELECTRIC CRUCIBLE,** for work requiring temperatures up to 1100° C. (2000° F.) for use on alternating current only.

The heating unit is of "Chromel" wire wound in the form of a core which radiates heat directly on the contents of the furnace. Surrounding the heating unit is a layer of special fire brick heat insulation, and outside of this, a sheet iron case.

These furnaces operate on low voltages (10 to 57 volts) and as regularly supplied for 110, 220 or 440 volts (60 cycles) circuit, require a transformer and controlling rheostat.

	a	b	c
Diameter, Chamber, inches	1½	2	4
Depth, Chamber, inches	1⅝	2½	6
Current Consumption, watts	650	1000	2000
Price, 110, 220 or 440 volts (60 cycles) A. C.	**$44.50**	**49.00**	**122.00**

NOTE:—**When ordering specify Line Voltage.**

5522 **FURNACES, ELECTRIC CRUCIBLE,** same as above, but **Furnace only,** without Transformer and Controlling Rheostat.

	a	b	c
Diameter, Chamber, inches	1½	2	4
Depth, Chamber, inches	1⅝	2½	6
Current Consumption, watts	650	1000	2000
Price, 110, 220 or 440 volts (60 cycles) A. C.	**$20.00**	**22.25**	**67.50**

NOTE:—**When ordering specify Line Voltage.**

EXTRA HEATING UNITS

When not heated above 1100° C. (2000° F.), the life of a heating unit should be at least 1000 hours. By having at hand extra heating units, immediate repairs can be made by the operator.

5525 **EXTRA HEATING UNIT** for Furnace Nos. **5520a** and **5522a** **$3.35**
5526 ——, for Furnace Nos. **5520b** and **5522b** **4.50**
5527 ——, for Furnace Nos. **5520c** and **5522c** **9.00**

5530 **FURNACE, ELECTRIC MUFFLE,** for work up to 1100° C. (2000° F.) for use on alternating current only.

The heating unit is in the shape of heavy hair pins which are distributed around the top, bottom and sides of a refractory muffle. Surrounding the heating units is a layer of special fire brick heat insulation and outside of this, a sheet iron case.

This furnace operates on low voltage and as regularly supplied, for 110, 220 or 440 volts (60 cycles) circuits, requires a transformer and a controlling rheostat.

Chamber 4¼ inches wide, 3 inches high, 9 inches long. Current consumption 2750 watts.
Complete with Transformer and Controlling Rheostat **130.00**
5530A ——, same as above, but **Furnace only,** without Transformer and Controlling Rheostat **67.50**
5533 **FURNACE, ELECTRIC MUFFLE,** same as No. **5530,** but designed so that temperature regulation is secured by regulating transformer.

This furnace is also mounted on an angle iron stand that brings the shelf 40 inches above the floor.
Chamber 7⅜ inches wide, 5 inches high, 12½ inches long. Current consumption, 6000 watts . . . **212.00**
5533A ——, same as above, but **Furnace only,** without Regulating Transformer **106.00**
5535 **FURNACE, ELECTRIC MUFFLE,** same as No. **5530,** but chamber 12 inches wide, 8 inches high, 19 inches long. Current consumption 12,500 watts. With Regulating Transformer **475.00**
5535A ——, same as above, but **Furnace only,** without Regulating Transformer **280.00**
5537 **FURNACE, ELECTRIC MUFFLE,** same as No. **5530,** but chamber 12 inches wide, 8 inches high, 26 inches long. Current consumption 15,000 watts. With Regulating Transformer **540.00**
5537A ——, same as above, but **Furnace only,** without Regulating Transformer **335.00**

NOTE:—When ordering any of the above Muffle Furnaces, **specify Line Voltage.**

EXTRA HEATING ELEMENTS

When not heated above 1100° C. (2000° F.) the life of a heating unit should be at least 1000 hours. By having at hand extra heating units, immediate repairs can be made by the operator.

5540 **EXTRA HEATING UNITS** for Furnace No. **5530** (10 per set) . . . . . Each Unit **1.15**
5541 ——, for Furnace No. **5533** (10 per set) . . . . . Each Unit **2.25**
5542 ——, for Furnace No. **5535** (14 per set) . . . . . Each Unit **3.35**
5543 ——, for Furnace No. **5537** (14 per set) . . . . . Each Unit **4.50**

Nos. 5545 to 5548

5545 **FURNACE, ELECTRIC TUBE** for work up to 1100° C. (2000° F.) for use on alternating circuits only, 110, 220 or 440 volts (60 cycles).
The heating unit is of "Chromel" wire, in the form of a coil which radiates heat directly on the contents of the furnace.
Surrounding the heat unit is a layer of special fire brick heat insulation, and outside of this, a sheet iron case. The temperature regulation is by means of a controlling rheostat.
Diameter of chamber, 1 inch, length, 11 inches. Current consumption 1000 watts. With Controlling Rheostat **$60.00**

5546 ——, same as above, but **Furnace only,** without Controlling Rheostat **33.50**

5547 **FURNACE, ELECTRIC TUBE,** same as No. **5545**, but diameter of chamber 1¼ inches, length 11 inches. Current consumption 1000 watts. With Controlling Rheostat **60.00**

5548 ——, same as above, but **Furnace only,** without Controlling Rheostat **33.50**

REPAIR PARTS

When not heated above 1100° C. (2000° F.) the life of the heating unit should be at least 1000 hours. By having at hand extra heating units, immediate repairs can be made by the operator.

5550 **EXTRA HEATING COIL** for Furnace No. **5545** **4.50**

5551 ——, for Furnace No. **5547** **4.50**

ELECTRIC FURNACE CORES

5565 **FURNACE CORES, ELECTRIC, ALUNDUM.** Alundum Refractory Cores have high heat conductivity and do not become electrical conductors when at the highest temperature obtained in the furnace. The wires should be protected by embedding them in Alundum Cement. Thus fully protected, they do not corrode under the most severe conditions, since the alundum mixtures are chemically inert.

	a	b	c	d	e	f	g	h	i	j	k
Bore, inches	1	1 7/16	2	2 1/16	2 1/16	2 1/16	3	3	3 1/2	5	5
Length, inches	10	12	10	2 7/16	2 7/16	5	7	24	5	9	12
Pitch, inch	1/9	5/16	1/9	5/16	5/16	5/16	5/16	1/4	5/16	5/16	1/3
Both Ends Open	**$4.25**	**4.50**	**4.50**		**1.15**	**2.25**		**13.50**	**4.50**		**7.25**
One End Closed				**$1.75**			**4.50**			**6.75**	

FURNITURE

No. 5575

5575 **STUDENTS' COMBINATION BIOLOGY TABLE.** The table illustrated is made up from four different units, — the table proper, two bottle racks and the case of drawers.

Table Proper. Body constructed of selected solid oak with top of selected narrow strips of kiln-dried maple, machined, matched and glued in a manner to prevent warping. A dividing strip runs lengthwise on the top through the center. Length, 6 feet, width, 3 feet, height, 30 inches.

Bottle Racks. One at each end is of unit construction and may, if desired, be added to the table proper at any time. It provides three shelves, the two lower being 4 inches apart. These racks will be found most convenient.

Case of Drawers. The case is designed to slide under the aprons and to extend front to back flush with the aprons. The sides are panelled and ends provided with four drawers. Width over all, 15 inches; height over all, about 24 inches.

Complete with Case of Drawers and two Bottle Racks **$48.00**

5575A **STUDENTS' BIOLOGY TABLE,** plain, same as above, but without Case of Drawers and without Bottle Racks **21.00**

5575B **CASE OF DRAWERS** for use with above table and as described under No. **5575** **22.00**

5575C **BOTTLE RACKS** for use on above or any table, and as described under No. **5575** . . . . . Each **4.50**

No. 5580

5580 **BIOLOGY LECTURE TABLE,** length over all, 9½ feet, width, 3 feet, height, 34 inches.

The body of table is constructed of selected kiln-dried solid oak, the top of narrow strips of straight grained maple, machined, matched and glued in a manner to prevent warping.

The front and ends are panelled, the back provided with a cupboard at each end and two large and two small drawers and a drop front compartment over the drawers between. The compartment over the drawers is intended for dissecting boards, large drawings, charts, etc.

The sink is of heavy construction, lined with sheet lead. It measures, inside, 22 × 20 × 12 inches deep and is fitted with a standing overflow 10½ inches high and with flush cover.

We supply our Triple Interchangeable Nozzle Goose-neck Faucet for water supply and our Four-way Gas Turret with Lever Handle Serrated End Gas Cocks for gas supply.

The top is treated and carbonized to make acid and alkali-proof. The body is finished in standard light antique color.

Without cocks . . . . . F. O. B. Factory **$140.00**

For **AQUARIUM** for this table, if desired, see No. **3527,** Page **406.**

No. 5590B

No. 1–725

No. 1–700

No. 5605

No. 5590A

No. 1–750

No. 5610

No. 5597

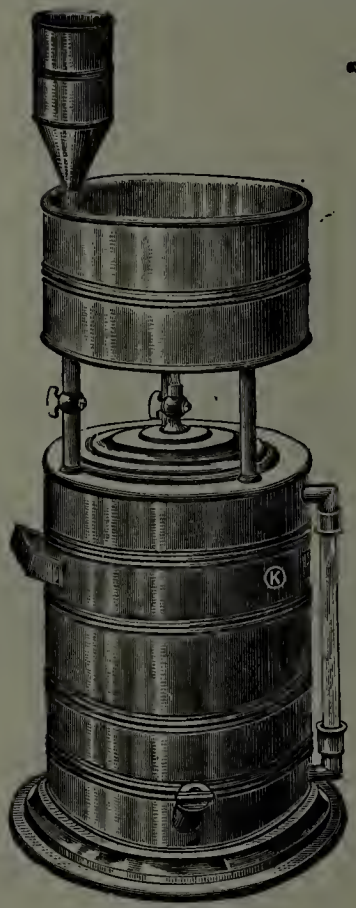
No. 5612

5590	**GAS APPARATUS** for **sulphur determinations,** according to Mr. C. D. Jenkins, Massachusetts State Inspector of Gas and Meters		**$12.50**
5590A	**GAS SAMPLE TUBES,** according to Mr. C. D. Jenkins		**1.00**
5590B	**GAS AMMONIA BULBS,** according to Mr. C. D. Jenkins		**1.00**
5593	**GAS BAGS,** pure gum rubber, without stopcock.	a	b
	Capacity, quarts	4	8
	Each	**$2.18**	**2.65**
5594	**GAS STOPCOCK** for use on above **GAS BAGS**		**.70**
5597	**GAS BOTTLE GENERATOR,** capacity 32 ounces, complete with fittings		**.90**

KNOTT'S GAS COCKS

The Knott Gas Cocks are of brass. The nipples are long, and with five sharp serrations which make it easy to slip on rubber tubing, but impossible to pull it off accidentally. Adjustment is secured by means of a lever handle.

1–700	**KNOTT'S LEVER HANDLE GAS COCK,** ⅛-inch I. P	**$0.55**
1–710	**KNOTT'S SINGLE GAS TURRET,** one gas cock	**1.45**
1–715	**KNOTT'S TWO-WAY GAS TURRET,** two gas cocks	**1.85**
1–720	**KNOTT'S THREE-WAY GAS TURRET,** three gas cocks	**2.25**
1–725	**KNOTT'S FOUR-WAY GAS TURRET,** four gas cocks	**2.65**
1–750	**THE KNOTT MOUNTED FOUR-WAY GAS TURRET.** The use of this design obviates all necessity of cutting a table top. It is connected by rubber tubing to a supply cock left at the floor line or above the table	**4.50**
5605	**GAS COLLECTOR (Beehive Shelf)** of **unglazed porcelain,** 2¾ inches high, for use in a sink or dish as the bottle rest for collecting gases over water	**.30**
5607	**GAS COLLECTOR (Packard's Glazed Porcelain Beehive Shelf).** This collector is provided with a recessed top for holding the neck of the bottle, and since it is but one inch high, requires very little water, thus permitting the use of a shallow dish. Excellent for lecture desk	**.18**
5610	**GAS GENERATOR, GASOLINE,** constructed wholly of brass, polished and nickeled. Height 7 inches, diameter 4½ inches. Interior contains 14 lineal feet of evaporating surface. Turret valve at top controls both gas and air outlets, also controls the size of the blowpipe flame. Built absolutely proof against any danger of flashing back of the flame. An air check is attached at the end of the filler tube to prevent over filling. Complete as illustrated	**9.75**
5612	**GAS GENERATOR, OXYGEN,** of polished metal, 9½ inches high, weighing but 2½ pounds. Capacity at one charge 27 liters, — nearly one cubic foot. The charge consists of an "Oxone Cartridge," a hermetically sealed tin which is to be punctured on top and bottom. Produces **pure** oxygen instantaneously. This oxygen is at low pressure and as it leaves the generator is 99.3 per cent. pure. As it leaves the wash bottle it is considered 100 per cent. pure oxygen. Simple and easy to handle, quickly recharged and always a source for obtaining pure oxygen instantly. Complete outfit is packed in a finished portable case and comprises the generator with wash bottle, awl for perforating the tin, four oxone cartridges and rubber tubing lead	**20.00**
	NOTE: — The above outfit, using "Hydrone" in place of "Oxone," may be used to generate **pure hydrogen.**	
5613	**"OXONE" CARTRIDGES,** sold only in two pound tins — Per Tin	**1.50**
5614	**"HYDRONE" CARTRIDGES,** sold only in two pound tins — Per Tin	**1.60**



No. 5616

No. 5625

No. 5642

Nos. 5628 and 5629

No. 5620

No. 5626

No. 12-295

5616 **GAS HOLDER, Gasometer,** Berzelius' and Pepy's, improved form, of heavy copper. Capacity, 5 gallons **$19.50**

5617 ——, capacity 10 gallons **24.50**

5620 **GAS MEASURING TUBES** for collecting gases over mercury. Subdivided by 1/5 cc.

	a	b
Capacity, cc.	50	100
Each	**$1.45**	**1.80**

5625 **GAS PRESSURE REGULATOR, Murrill's Improved,** for use with a thermostat. A constant temperature can be maintained regardless of the pressure variations in the gas supply. With two outlets as illustrated **$9.75**

5626 **GAS REGULATOR,** Reichert's, adapted for water baths, drying ovens, incubators, sterilizers, etc. Secures constant temperature at any desired point from 1° C. up to the boiling point of mercury **3.25**

5628 **GAS REGULATOR, Roux Bi-metallic,** an accurate gas regulator, simple in construction, easily operated and adjusted to regulate an even temperature more constantly than any other thermo-regulator. Not liable to leak as it is made entirely of metal. Particularly well adapted for ovens and sterilizers. Length 10 inches. Complete with directions **8.50**

5629 **GAS REGULATOR, Roux Bi-metallic.** Same as above, but for high temperatures **9.75**

GAS STOVES. See **STOVES,** Pages **483** and **484.**

12-295 **GAUGE, POLISHED STEEL, INSIDE TAPER,** for inside measure of tubes, holes, etc. Made of hardened polished steel and about 18 centimeters long. Will measure from 1/10 to 15 millimeters **.80**

5632 **GAUZE, ASBESTOS CENTER,** tinned iron wire, 5 × 5 inches with asbestos compressed in the mesh. Excellent for slow evaporations . . . . . Each **.10**

5634 **GAUZE, COPPER,** thick wire, mesh selected for use in heating chemical ware.

	a	b	c
Size, inches	4 × 4	6 × 6	12 × 12
Each	**$0.10**	**.20**	**.70**

5635 **GAUZE, COPPER,** 80 mesh, 4 × 4 inches . . . . . **.18**

5637 **GAUZE, IRON,** thick wire, mesh selected for use in heating chemical ware.

	a	b	c
Size, inches	4 × 4	6 × 6	12 × 12
Each	**$0.04**	**.07**	**.27**

GENUS COVERS. See Page **472.**

3635 **GLASS, LECTURE,** for use on lecture desk for a large class of chemical experiments. Capacity 350 cc. (For illustration see Page **412**) . . . . . **.60**

5642 **GLASSES, TEST, on foot,** clear colorless glass.

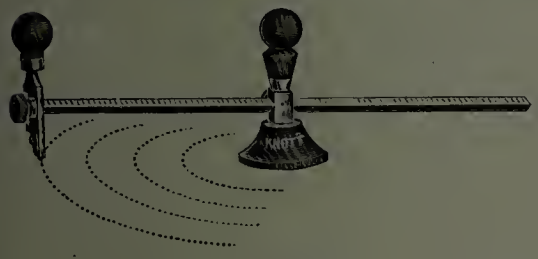
	a	b
Capacity, ounces	2	4
Each	**$0.40**	**.45**

3615 **GLASS BEADS,** hollow, for filtering or drying gases by means of acid . . . . . Per Pound **.95**

No. 5645

No. 5646

No. 5650



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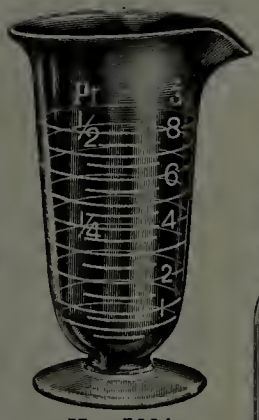
No. 5666



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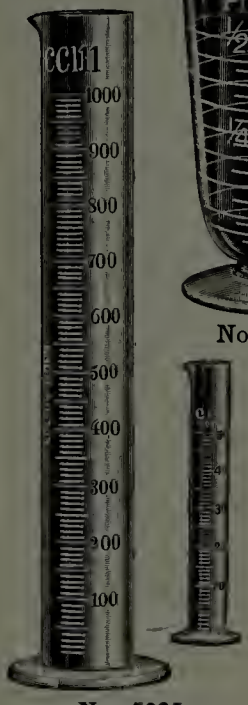


No. 5095

No. 5098

GLASS BLOWERS' FIRES. See **BLOWPIPES,** Page **415.**

5645 **GLASS CUTTER,** single steel wheel, with metal handle **$0.07**

5646 **GLASS CUTTER, TURRET HEAD.** Turret contains six high grade steel wheels, hardened and tempered and carefully tested. Ebony finished handle, nickeled ferrule, highly polished . . . . . **.30**

5649 **GLASS CUTTING DIAMOND,** excellent quality **5.40**

5650 **GLASS TUBE CUTTER, BUNSEN'S,** a practical tool with steel wheel, hardened and tempered . . . **.60**

5651 **GLASS TUBE CUTTER** for tubes up to ⅞-inch diameter, inexpensive but efficient, rapid and practical **.30**

5653 **GLASS CUTTER FOR CIRCLES.** Cuts circles from 2½ to 22½ inches in diameter. Cutter head is interchangeable, allowing for renewing of cutters, and is secured firmly to the graduated rod marked to ⅛ inches. All parts nickel-plated. Hardwood handles and base with felt covered bottom **1.35**

6330 **GLASS PLATES** for covers.

	a	b	c
Size, inches	4 × 4	5 × 5	6 × 6
Each	**$0.03**	**.04**	**.05**

GLASS RODS. See **RODS, GLASS,** Page **477.**

6482 **GLASS RODS, stirring rods,** finished ends.

	a	b
Size, mm.	5 × 150	6 × 150
Per Dozen	**$0.16**	**.20**

GLASS TUBING. See **TUBING, GLASS,** Page **491.**

5660 **GLASS WOOL** for filtering acids, etc. . . . . Per ounce **.50**

5662 **GOLD BEATERS' SKIN** . . . . . **.10**

5664 **GRADUATES, conical,** graduated in ounces.

	a	b	c	d	e	f	g
Capacity, ounces	½	1	2	4	8	16	32
Each	**$0.20**	**.22**	**.25**	**.30**	**.50**	**.70**	**1.10**

5666 **GRADUATES, conical,** graduated in cubic centimeters.

	a	b	c	d	e	f
Capacity, cc.	30	60	100	250	500	1000
Each	**$0.25**	**.28**	**.32**	**.55**	**.81**	**1.25**

5667 **GRADUATES, conical,** graduated in both ounces and cubic centimeters.

	a	b	c	d	e	f
Capacity, ounces	1	2	4	8	16	32
Capacity, cc.	30	60	125	250	500	1000
Each	**$0.30**	**.36**	**.45**	**.65**	**1.00**	**1.65**

5095 **GRADUATES, CYLINDRICAL,** of glass, broad base, with lip, graduated in cubic centimeters.

	a	b	c	d	e	f	g
Capacity, cc.	10	25	50	100	250	500	1000
Each	**$0.30**	**.36**	**.40**	**.52**	**.90**	**1.10**	**1.85**

5096 **GRADUATES, CYLINDRICAL, double graduations,** reading up and down, of glass, broad base, with lip, graduated in cubic centimeters.

	a	b	c	d	e	f
Capacity, cc.	25	50	100	250	500	1000
Each	**$0.38**	**.45**	**.56**	**.95**	**1.20**	**2.00**

5098 **GRADUATES, MIXING, STOPPERED,** serviceable when making standard solutions. Of glass, broad base, round glass stoppers, graduated in cubic centimeters.

	a	b	c	d	e	f	g
Capacity, cc.	25	50	100	200	250	500	1000
Each	**$0.75**	**.85**	**.95**	**1.20**	**1.30**	**1.85**	**2.25**

No. 5671

HEATER, ELECTRIC, WATER. See **ELECTRIC APPLIANCES,** Page **436.**
HEATERS, SOLDERING IRON. See **SOLDERING IRON HEATERS,** Page **479.**
HOT PLATES. See **STOVES,** Pages **483** and **484,** and **BATHS, SAND,** Page **409.**

HYDROMETERS

Our line of hydrometers has been selected with unusual care to cover the requirements not only of commercial, but also of educational laboratories as well. We believe we have covered general requirements. We most respectfully solicit correspondence relative to special individual requirements which are not met in the following listings.

31–170	**HYDROMETER** for light liquids, double scale, Beaume, 70 to 10, Specific Gravity, 0.7000 to 1.000	$0.60
31–171	**HYDROMETER** for heavy liquids, double scale, Beaume, 0-70, Specific Gravity, 1.000 to 2.000	.60
31–175	**HYDROMETER,** Specific Gravity Scale only, for both light and heavy liquids. Range 0.7000 to 2.000	1.25
5668A	**HYDROMETER,** Twaddle Scale, 0° to 24°, ½° graduation	.85
5668B	——, 24° to 48°, ½° graduation	.85
5668C	——, 48° to 72°, ½° graduation	.85
5668D	——, 72° to 100°, ½° graduation	.85
5668E	——, 100° to 134°, ½° graduation	.85
5668F	——, 134° to 180°, ½° graduation	.85
5669A	**HYDROMETER,** Specific Gravity scale, 0.600 to 0.700, .02° graduation	1.00
5669B	——, 0.700 to 0.800, .02° graduation	1.00
5669C	——, 0.800 to 0.900, .02° graduation	1.00
5669D	——, 0.900 to 1.000, .02° graduation	1.00
5669E	——, 1.000 to 1.200, .05° graduation	1.00
5669F	——, 1.200 to 1.400, .05° graduation	1.00
5669G	——, 1.400 to 1.600, .05° graduation	1.00
5669H	——, 1.600 to 1.800, .05° graduation	1.00
5669I	——, 1.800 to 2.000, .05° graduation	1.00
5670A	**HYDROMETER,** Beaume Scale, coal oil hydrometer, 10° to 50°, 1° graduation	.75
5670B	——, 40° to 70°, 1° graduation	.75
5670C	——, 60° to 100°, 1° graduation	.75
5671	**HYDROMETER** for storage batteries, consisting of the hydrometer proper inside a glass tube with a rubber bulb at the top and a rubber tube at the bottom. The rubber tube may be inserted in the storage battery, a quantity of acid withdrawn into the glass tube, the reading taken and the liquid replaced within a few seconds, and with great convenience. Outfit complete	1.65
5672	**HYDROMETER,** similar to the one used in the above set, scale 1.150° to 1.300°, .005° graduation. Length about 5 inches. With test jar in wooden case	.75
6136	**LACTOMETER,** Spence's, New York Board of Health pattern, 0° to 120°, 2° graduation	1.00
6137	**LACTODENSIMETER,** Quevenne's Pattern, scale 15° to 40° (1.015 to 1.040 Specific Gravity), 1° graduation	1.00
5673A	**ALCOHOLOMETER,** Proof Scale, 50° below proof to 0° (proof), 1° graduation	1.00
5673B	**ALCOHOLOMETER,** Proof and Tralle Scale, 100° below to 100° above proof; 0° to 100° Tralle; 1° graduation	1.00
5674A	**HYDROMETER,** for Sugar, Brix scale, 0 to 30°, ½° graduation	1.00
5674B	——, 30° to 60°, ½° graduation	1.00
5674C	——, 60° to 90°, ½° graduation	1.00

31-250 HYDROMETER JARS or CYLINDERS, of clear white glass, with foot and rim.

	a	b	c	d	e
Size, inches	12 × 1½	12 × 2	15 × 2	15 × 3	18 × 3
Each	$0.50	.55	.80	1.00	1.35

HYPERDERMIC SYRINGE. See **SYRINGE, HYPERDERMIC,** Page **486.**

INCUBATORS

Nos. 5680 and 5682

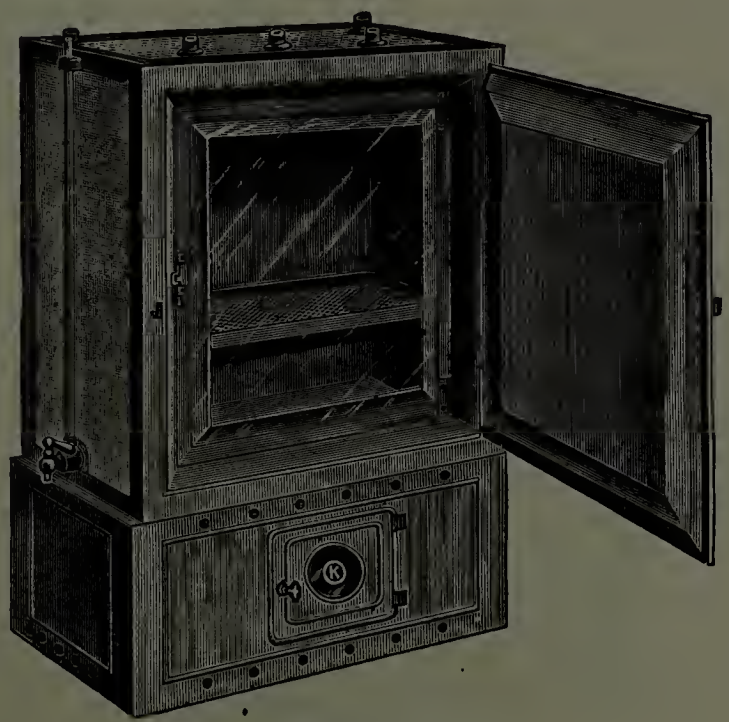
No. 5683

5680 **INCUBATOR, POLISHED COPPER, double wall,** sheet iron base 9 inches high,— otherwise the same as the Triple Wall Incubators Nos. **5685** to **5688**. Inside dimensions 10 inches high, 8 inches wide, 8 inches deep; outside, 13 inches high, 11½ inches wide, 11½ inches deep. With one shelf **$42.50**

5682 **INCUBATOR, POLISHED COPPER, double wall,** same as above, but inside dimensions, 12 inches high, 10 inches wide, 10 inches deep; outside, 15 inches high, 13½ inches wide, 13½ inches deep . **52.50**

5683 **INCUBATOR, POLISHED COPPER, double wall,** the outer one covered with insulating material. Two-inch water space, water gauge and stopcock. Base is of sheet iron and is 9 inches high. A glass plate in the top permits of examination of contents without opening the top. Inside measurements, 8 × 9 inches; outside, 12 × 12 inches. With one perforated tray **19.50**

5685 **INCUBATOR, POLISHED COPPER, three wall,** having both air and water space, the outer surface being covered with insulating material to insure an even temperature. **Double doors,** the inner one of beveled glass to permit observation of cultures without disturbing the temperature. Tubulations for gas regulator, thermometer and for filling water space. Supported on a sheet iron base, 10 inches high, finished in durable black, having a door with an opening covered with mica for observation of the flame. Inside dimensions, 9 inches high, 7 inches wide, 7 inches deep. Outside dimensions, 13 inches high, 11 inches wide and 10½ inches deep. With one shelf **$43.75**



Nos. 5685 and 5686

5686 **INCUBATOR, POLISHED COPPER, three wall,** having both air and water space. Same as above, but inside dimensions 12 inches high, 9 inches wide, 9 inches deep. Outside dimensions, 17 inches high, 14 inches wide, 13 inches deep. With one shelf **$54.00**

5687 INCUBATOR, POLISHED COPPER, three wall.
Same as **No. 5685,** but height of base 11 inches and inside dimensions, 14 inches high. 12 inches wide, 10 inches deep. Outside dimensions, 19 inches high, 17 inches wide, 14 inches deep. With two shelves **$72.00**

5688 INCUBATOR, POLISHED COPPER, three wall.
Same as above, but inside dimensions, 20 inches high, 18 inches wide, 10 inches deep. Outside dimensions, 25½ inches high, 23¼ inches wide, 14¾ inches deep. With two shelves **98.00**

Nos. 5687 and 5688

INCUBATORS, ELECTRICALLY HEATED WITH ELECTRICAL CONTROL

Can be used on Direct or Alternating Current

Nos. 5690 to 5693

The following incubators are the same sizes and have the same points of excellence as Nos. **5685** to **5688.** They are, however, built with proper insulation for electrical heating. If at any time it should be desired to use these incubators on gas, the electric attachment may readily be removed.

The electric regulator is a device, simple and practical in construction, and one quite easily operated. When once set, it requires absolutely no attention and there will hardly be a noticeable variation in temperature. Operation by expanded mercury, positively insures the finest adjustment.

5690 ELECTRIC INCUBATOR, 9 × 7 × 7 inches, inside measurements. With one shelf **$96.00**

5691 ——, 12 × 9 × 9 inches, inside measurements. With one shelf . . **110.00**

5692 ——, 14 × 12 × 10 inches, inside measurements. With two shelves **136.00**

5693 ——, 20 × 18 × 10 inches, inside measurements. With two shelves **165.00**

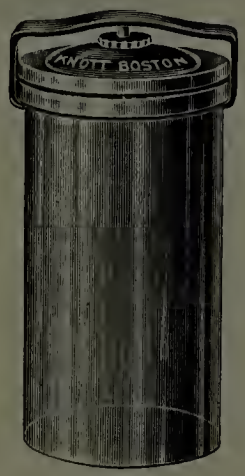
5700 INK, DIAMOND, for writing on glass, labeling bottles, beakers, etc. Per ounce . . . . . **.75**

IRON, ELECTRIC. See **ELECTRIC APPLIANCES,** Page **436.**

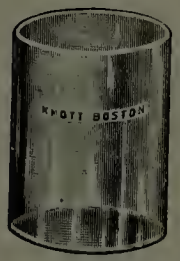
No. 5730

No. 5727

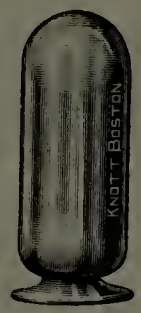
No. 5705



No. 5715



No. 31–265



No. 5720

No. 5717

a b c
No. 6945

JARS, AQUARIA. See AQUARIA, Page 406.

31–265 JARS, BATTERY, of excellent quality.

	a	b	c	d
Size, inches	2¼ × 3¼	4 × 5	6 × 8	8 × 12
Each	$0.12	.25	.40	1.50

91–380 JARS, RECTANGULAR BATTERY, of excellent quality.

	a	b
Size, inches	2½ × 4¼ × 7	4 × 4 × 8
Each	$0.35	.45

5705 JAR, CALCIUM CHLORIDE (Drying Tower). Clear white glass, 10 inches high $1.00

5095 JARS, GRADUATED, CYLINDRICAL. Of glass, broad base, with lip, graduated in cubic centimeters.

	a	b	c	d	e	f	g
Capacity, cc.	10	25	50	100	250	500	1000
Each	$0.30	.36	.40	.52	.90	1.10	1.85

5096 JARS, GRADUATED, CYLINDRICAL, double graduations, reading up and down. Of glass, broad base, with lip, graduated in cubic centimeters.

	a	b	c	d	e	f
Capacity, cc.	25	50	100	250	500	1000
Each	$0.38	.45	.56	.95	1.20	2.00

5098 JARS, GRADUATED, MIXING, STOPPERED. Of glass, broad base, round glass stoppers, graduated in cubic centimeters.

	a	b	c	d	e	f	g
Capacity, cc.	25	50	100	200	250	500	1000
Each	$0.75	.85	.95	1.20	1.30	1.85	2.25

31–250 JARS, HYDROMETER, of clear white glass, with foot and rim.

	a	b	c	d	e
Size, inches	12 × 1½	12 × 2	15 × 2	15 × 3	18 × 3
Each	$0.50	.55	.80	1.00	1.35

5715 JARS, MUSEUM, for preserving and displaying specimens in laboratories and museums. Of clear colorless glass. Mouth same width as inside diameter. Contents securely sealed by a metal clamp which binds the glass cover to jar with thin rubber gasket between. On the under side of the cover are two glass rings from which specimens may be suspended.

	a	b	c	d	e
Height, without Lid, inches	4	8	8	8	12
Width of Mouth, inches	2¼	2¼	3½	5	5
Approximate Capacity, pints	½	1	2½	5½	8
Each	$0.65	.70	1.00	1.90	2.10

5717 JAR, STAINING, COPLIN'S, for use in staining sections for microscopic work. With glass lid ground on shoulder. For ten slides 35

6945 JARS, NESSLER, for ammonia tests in water analysis; of colorless glass.

	a	b	c
Graduated, cc.	50	100	50 and 100
Each	$0.65	.80	.95

5720 JARS, SHOW, INVERTED, clear, colorless glass.

	a	b	c	d
Capacity, pints	½	1	2	4
Each	$0.20	.26	.36	.60

5727 JARS, STORAGE, "Lightning Sealing," for chemical, biological and botanical specimens.

	a	b	c	d
Capacity, pints	½	1	2	4
Each	$0.10	.12	.14	.20

5730 JAR, WASTE, stoneware. Capacity 3 gallons, with cover and handles 85

No. 5765

No. 5770

No. 5773

5750 **LABELS, GUMMED, red border,** in boxes.

Trade No.	217	213	209	205	201	2004	2007	2002	2001	2006	2005	2003
Length, inches	1	1¼	1½	1¾	2½	2¾	3	3⅞	3⅞	4⅛	4⅛	4¾
Width, inches	⅞	1	1⅛	1⅜	1½	1	1⅝	1⅛	1⅝	1¾	2	2
Per Box	**$0.07**	**.07**	**.07**	**.07**	**.07**	**.17**	**.20**	**.20**	**.25**	**.30**	**.33**	**.42**

5753 **LABELS, GUMMED,** perforated, in rolls, 1000 labels in a roll. Numbers given are same sizes as above. Each roll contained in a special box with slot opening so that labels can be drawn out as needed without opening the box.

	a	b	c	d
Trade No.	205	209	217	221
Per Roll	**$0.80**	**.75**	**.65**	**.60**

5758 **LABELS, CHEMICAL,** in book, names and symbols for all chemicals and reagents in general use in laboratories. Gummed and perforated so that any label may be removed without destroying the book . . . . . Per Book **$0.45**

5760 **LABELS, MICROSCOPIC SLIDE,** ½ × ⅞ inch, gummed . . . . . Per Box **.10**

5761 **LABELS, MICROSCOPIC SLIDE,** ⅞ × ⅞ inch, gummed, black border . . . . . Per Box **.10**

LACTOMETERS. See **MILK TESTING APPARATUS,** Page **468.**

5765 **LADLE, COPPER** with **wood handle.** Diameter of bowl 1½ inches, depth 1¼ inches, extreme length 8 inches . . . . . **.50**

5770 **LAMPS, ALCOHOL,** of colorless glass, with ground glass cap, wick and wick holder.

	a	b
Capacity, ounces	4	8
Each	**$0.25**	**.40**

5770A **LAMP WICKS** for above glass Alcohol Lamps . . . . . Per Dozen **.18**

5773 **LAMP, POLISHED BRASS, ALCOHOL, nickel-plated.** Capacity 2 ounces . . . . . **.65**

5773A **LAMP WICKS,** special for above . . . . . Per Dozen **.18**

LAMPS, BLAST. See pages **201** and **202.**

LEAD DISHES. See **DISHES, LEAD,** Page **432.**

5780 **LITMUS PAPER, red,** in sheets . . . . . Per Sheet **.04.** Per Quire **.66**

5781 **LITMUS PAPER, red,** in books of strips . . . . . Per Book **.06**

5782 **LITMUS PAPER, blue,** in sheets . . . . . Per Sheet **.04.** Per Quire **.66**

5783 **LITMUS PAPER, blue,** in books of strips . . . . . Per Book **.06**

5789 **LITMUS PENCIL** . . . . . **.25**

5795 **LOGARITHM TABLES,** a heavy board card, 14½ × 9½ inches, with four place tables of logarithms and anti-logarithms, with table of atomic weights, also Factors for Analysis. Computed by Dr. Hubert G. Shaw. This card is of convenient size for students' use in the laboratory. Used extensively and for years at the Massachusetts Institute of Technology . . . . . Each **.35**

MAGNIFIERS

Our line of magnifiers has been selected with the greatest care. We list below types that have succeeded best in meeting the diversified requirements of science laboratories and feel, therefore, that our customers will be able to select the type or types best suited to their particular needs.

No. 5815

No. 5820

No. 5823

No. 5825

No. 74–235

5815 **MAGNIFIER, TRIPOD,** giving a large clear field and a magnification sufficient for elementary work. The lens may be focussed by screwing it up and down in its frame **$0.56**

5817 **MAGNIFIER, POCKET, single,** ¾ inch lens, mounted and encased in vulcanite . . . . . **.40**

5819 **——, single,** same as above, but lens 1 inch in diameter . . . . . **.50**

5820 **——, double,** ⅝ and ¾ inch lenses mounted and encased in vulcanite . . . . . **.68**

5821 **——, double,** ⅞ and 1 inch lenses, mounted and encased in vulcanite . . . . . **.80**

5823 **——, triple,** ⅝, ¾ and ⅞ inch lenses, mounted and encased in vulcanite . . . . . **.95**

5825 **MAGNIFIER, CODDINGTON,** sharp definition, large, clear, flat field. Mounted in nickel-plated brass case **1.50**

74–235 **MAGNIFIER, FOLDING (LINEN TESTER),** brass mounted, short focus, ½ inch aperture . . . . **.44**

74–230 **MAGNIFIER, READING (Reading Lens),** diameter 3 inches, in nickel-plated brass mount, polished wood handle **1.00**

Nos. 5835 to 5839

Nos. 5841 to 5845

Nos. 5847 to 5851

DOUBLET MAGNIFIERS. These magnifiers are composed of two separate plano-convex lenses, very carefully and accurately ground and polished and substantially set in their mounts. Nos. **5835** to **5839** are black lacquered and Nos. **5841** to **5851** are nickel-plated. Excellent definition and an exceptionally flat field with greatest focal length are characteristics of these lenses.

For use on Dissecting Stands.

5835 **6X DOUBLET MAGNIFIER,** 41.6 mm. (1.6 inches) focal distance, working distance 22 mm., field 22 mm. **$1.00**

5836 **9X DOUBLET MAGNIFIER,** 27.8 mm. (1.1 inch) focal distance, working distance 15 mm., field 16 mm. **1.00**

5837 **12X DOUBLET MAGNIFIER,** 20.8 mm. (0.8 inch) focal distance, working distance 12 mm., field 11 mm. **1.00**

5838 **18X DOUBLET MAGNIFIER,** 13.9 mm. (0.5 inch) focal distance, working distance 8 mm., field 8 mm. **1.25**

5839 **24X DOUBLET MAGNIFIER,** 10.4 mm. (0.4 inch) focal distance, working distance 6 mm., field 5.5 mm. **1.50**

With Hexagonal Handles for use on the Desk.

5841 **6X DOUBLET MAGNIFIER,** 41.6 mm. (1.6 inches) focal distance, working distance 22 mm., field 22 mm. **1.00**

5842 **9X DOUBLET MAGNIFIER,** 27.8 mm. (1.1 inches) focal distance, working distance 15 mm., field 16 mm. **1.00**

5843 **12X DOUBLET MAGNIFIER,** 20.8 mm. (0.8 inch) focal distance, working distance 12 mm., field 11 mm. **1.00**

5844 **18X DOUBLET MAGNIFIER,** 13.9 mm. (0.5 inch) focal distance, working distance 8 mm., field 8 mm. **1.25**

5845 **24X DOUBLET MAGNIFIER,** 10.4 mm. (0.4 inch) focal distance, working distance 6 mm., field 5.5 mm. **1.50**

In Folding Pocket Cases.

5847 **6X DOUBLET MAGNIFIER,** 41.6 mm. (1.6 inches) focal distance, working distance 22 mm., field 22 mm. **1.25**

5848 **9X DOUBLET MAGNIFIER,** 27.8 mm. (1.1 inches) focal distance, working distance 15 mm., field 16 mm. **1.25**

5849 **12X DOUBLET MAGNIFIER,** 20.8 mm. (0.8 inch) focal distance, working distance 12 mm., field 11 mm. **1.25**

5850 **18X DOUBLET MAGNIFIER,** 13.9 mm. (0.5 inch) focal distance, working distance 8 mm., field 8 mm. **1.50**

5851 **24X DOUBLET MAGNIFIER,** 10.4 mm. (0.4 inch) focal distance, working distance 6 mm., field 5.5 mm. **1.50**

MANIKINS

The manikin is a reproduction of the Complete Anatomy of the human body in all its details, and is an invaluable aid in teaching Physiology.

It can be hung upon the wall closed, occupying the space of a picture. Open it and you will see fold after fold that can be turned just as you would turn the pages of a book. Each fold is a picture of some part of the Complex Anatomy.

Every muscle, ligament, bone, nerve, vein, artery and organ is seen in its natural position.

Every such part is numbered and its name and purpose is learned by reference to the index that accompanies the Manikin.

The Pilz Manikin, life size, shows every detail of the human body full size, thirty folds being necessary to accomplish this.

It is of indestructible linen-centered cardboard and will last a lifetime.

Size: 5 feet, 5 inches high.

Number of Parts. There are 455 parts covering all the Anterior and Posterior Muscles, Circulation of the Blood, Nervous System, Skeleton and Viscera.

5855 **Male** full size, each **$13.50**

5856 **Female** full size, each **17.50**

5857 **Sexless** full size, each **13.50**

Dr. Minder's Manikins are of smaller size, but contain all of the essential features of the above. They are of special interest to schools not able to purchase the large size editions.

Size: Twenty (20) inches tall.

Number of Parts. Minder's Manikins contain 384 distinct parts, covering the Muscles, Circulation of the Blood, Nervous System, Skeleton and Viscera.

5859 **Female,** each **$3.50**

5860 **Sexless,** each **2.75**

A key and descriptive text with all parts named and numbered is furnished.

In ordering be particular to state which manikin is wanted, male, female or sexless.

COMPOUND MICROSCOPES

No. 5870

The microscopes listed as follows with the exception of Nos. **5868** and **5870** are the product of the Spencer Lens Company. The best of material is used and is worked by the best modern machinery in the hands of men of skilled mechanics, carefully trained, each to his particular work.

The stands are for the most part in a neat black finish which is baked in at a high temperature and which is resistant to wear, to acid, to alcohol, and all the common reagents. This effect is heightened by the yellow finish of the smaller parts. This yellow finish is also alcohol and reagent proof.

We call particular attention to features which are peculiar to these microscopes.

Unexcelled Optics.
Fine adjustments are automatically lubricated and protected from dust.
All fine adjustments are so protected that no harm can come to them from handling the microscope by the arm.
All fine adjustments cease to work when the objective rests on the cover glass.
No lost motion or lateral displacement in either type of fine adjustment.
Unusually large stages on which the vulcanite stages are vulcanized directly to the metal stage.
Unexcelled optical and mechanical workmanship throughout.

5868 COMPOUND MICROSCOPE, SMALL. This microscope, though but 7 inches high, is an efficient compound microscope for the general work of a school laboratory. Constructed of brass throughout and handsomely finished. Stage is large and provided with nickel-plated spring clips. Furnished with ocular and three objectives giving magnifications of 30, 50, and 80 diameters. In box with receptacle for slides and forceps **$9.80**

5870 COMPOUND MICROSCOPE, a low priced instrument of exceptionally fine quality well adapted for school laboratories. It is a full size instrument conforming to standards by Royal Microscopical Society, and objectives and oculars of any other make conforming to the same standards, may be added to its equipment.

Stage, 2¾ × 2⅞ inches, has attached to it a supplementary micrometer stage affording a very delicate fine adjustment with nickel-plated spring stage clips.

Stand is made entirely of brass, handsomely finished in lacquer and black enamel. The **draw tube** is 160 mm. long and is nickel-plated and polished where it slides in the main tube.

Mirror is plane, 1⅜ inches diameter, so mouthed that it can be adjusted to any angle. With a 7X ocular and a ⅔ and 1 inch divisible objective, in case **13.50**

COMPOUND MICROSCOPES, suggested for commercial, household or elementary school purposes where the magnification required is not great.

Focussing adjustment, coarse adjustment only, by rack and pinion.

Stage of brass, black lacquered. Measures 112 × 108 mm. and distance of optical axis to base of arm is 75 mm.

Mirror, plano-concave, 50 mm. diameter, on swing bar.

5873 ——, with **divisible objective 32-14 mm.** and **10X ocular** giving magnifications of 35 and 130 diameters **$17.50**

5873A ——, with **divisible objective 32-14 mm.** and **5 mm. special objective** and **6X and 10X oculars** giving magnifications of 17, 35, 65, 130 and 360 diameters **23.00**

5873B ——, same as above, but with **revolving dust-proof double nosepiece** **27.00**

5873C ——, with **16 and 4 mm. objectives** and **10X ocular** giving magnifications of 100 and 440 diameters **25.50**

5873D ——, same as above, but with **revolving dust-proof double nosepiece** **29.50**

No. 5873

Nos. 5876 to 5876E

Nos. 5878 to 5878E

Nos. 5880 to 5880F

MICROSCOPES, side fine adjustment. Stage 108 mm. deep × 112 mm. wide, with iris diaphragm in the stage.

Plano-concave mirror 50 mm. diameter. Coarse and fine adjustments. The fine adjustment located on the side is of simplest possible construction and cannot get out of order. One complete revolution of shaft raises or lowers the body tube .2 millimeter.

5876 ——, with **16 and 4 mm. objectives and 10X ocular** giving magnifications of 100 and 440 diameters . **$30.00**

5876A ——, same as above, but with **revolving dust-proof double nosepiece** **34.00**

5876B ——, with **16 and 4 mm. objectives and 6X and 10X oculars** giving magnifications of 60, 100, 264 and 440 diameters **31.50**

5876C ——, same as above, but with **revolving dust-proof double nosepiece** **35.50**

5876D ——, with **Abbe Condenser** (N. A. 1.20) **16 and 4 mm. objectives** and **10X ocular** giving magnifications of 100 and 440 diameters **39.50**

5876E ——, with **Abbe Condenser** (N. A. 1.20) **16 and 4 mm. objectives,** with **revolving dust-proof double nosepiece,** and **6X and 10X oculars** giving magnifications of 60, 100, 264 and 440 diameters . . . **41.00**

MICROSCOPES, top lever type, fine adjustment, stage 108 mm. deep by 112 mm. wide, with iris diaphragm in the stage, plano-concave mirror 50 mm. diameter. Both coarse and fine adjustments. One complete revolution of shaft raises or lowers the body tube .5 millimeter.

5878 ——, with **16 and 4 mm. objectives and 10X ocular** giving magnifications of 100 and 440 diameters . . **27.50**

5878A ——, same as above, but with **revolving dust-proof double nosepiece** **31.50**

5878B ——, with **16 and 4 mm. objectives** and **6X and 10X oculars** giving magnifications of 60, 100, 264 and 440 diameters **29.00**

5878C ——, same as above, but with **revolving dust-proof double nosepiece** **33.00**

5878D ——, with **Abbe Condenser** (N. A. 1.20) **16 and 4 mm. objectives,** with **revolving dust-proof double nosepiece,** and **10X ocular** giving magnifications of 100 and 440 diameters **37.00**

5878E ——, with **Abbe Condenser** (N. A. 1.20), **16 and 4 mm. objectives,** with **revolving dust-proof double nosepiece,** and **6X and 10X oculars** giving magnifications of 60, 100, 264 and 440 diameters **38.50**

COMPOUND MICROSCOPES suggested to micro-biologists who desire an efficient, yet comparatively inexpensive instrument.

Side fine adjustment of very simple yet practical construction. Cannot get out of order. One complete revolution of shaft moves body tube $\frac{2}{10}$ mm.

Stage, vulcanized top and sides, is 112 mm. wide by 108 mm. deep. Working space 80 mm. from arm to optical axis.

Substage. A sextuple screw, protected from dust, carries the substage arm up and down on a perpendicular axis, around which the arm is free to revolve when at the lower limit of the screw. When at the lower limit the arm may be swung out of the optical axis, carrying with it the small iris diaphragm fastened to its upper surface, and also the condenser with its larger iris. The small upper iris is automatically locked open when the condenser is in place.

5880 ——, with **16 and 4 mm. objectives** and **10X ocular** giving magnifications of 100 and 440 diameters . **$31.50**

5880A ——, same as above but with **revolving dust-proof double nosepiece** **35.50**

5880B ——, with **16 and 4 mm. objectives** and **6X and 10X oculars** giving magnifications of 60, 100, 264 and 440 diameters **33.00**

5880C ——, same as above, with **revolving dust-proof double nosepiece** **37.00**

5880D ——, with **Abbe Condenser** (N. A. 1.20), **16 and 4 mm. objectives** with **revolving dust-proof double nosepiece,** and **10X ocular** giving magnifications of 100 and 440 diameters **41.00**

5880E ——, with **Abbe Condenser** (N. A. 1.20), **16 and 4 mm. objectives,** with **revolving dust-proof double nosepiece** and **6X and 10X oculars** giving magnifications of 60, 100, 264 and 440 diameters **42.50**

5880F ——, with **Abbe Condenser** (N. A. 1.20), **16, 4 and 1.8 mm. (oil immersion) objectives** with **revolving dust-proof triple nosepiece** and **6X and 10X oculars** giving magnifications of 60, 100, 264, 440, 570 and 950 diameters **67.50**

No. 5882

No. 5885

COMPOUND MICROSCOPE suggested for advanced laboratory research work and clinical work of the most exacting character.

Side fine adjustment having no lost motion and no side thrust, automatically taking up for any wear as it may occur. Each of the one hundred divisions of the graduated button represents a movement of 1 micron.

Stage, 110 × 95 mm., is of brass, covered top and edges with rubber vulcanized directly to the stage plate.

Substage. A sextuple screw, protected from dust, carries the substage arm up and down on a perpendicular axis, around which the arm is free to revolve when at the lower limit of the screw. When at the lower limit, the arm may be swung out of the optical axis, carrying with it the small iris diaphragm fastened to its upper surface, and also the condenser with its larger iris. The small upper iris is automatically locked open when the condenser is in place.

5882 ——, with **Abbe Condenser** (N. A. 1.20), **16 and 4 mm. objectives** and **10X ocular** giving magnifications of 100 and 440 diameters **$54.00**

5882A ——, same as above, but with **revolving dust-proof double nosepiece** **58.00**

5882B ——, with **Abbe Condenser** (N. A. 1.20), **16 and 4 mm. objectives and 6X and 10X oculars** giving magnifications of 60, 100, 264 and 440 diameters **55.50**

5882C ——, same as above, but with **revolving dust-proof double nosepiece** **59.50**

5882D ——, with **Abbe Condenser** (N. A. 1.20), **16, 4 and 1.8 mm. (oil-immersion) objectives,** with **revolving dust-proof triple nosepiece,** and **6X and 10X oculars,** giving magnifications of 60, 100, 264, 440, 570 and 950 diameters **85.00**

COMPOUND MICROSCOPE suggested to micro-biologists who demand a large and very efficient instrument where critical work is a necessity.

Side fine adjustment having no lost motion and no side thrust; automatically taking up for any wear as it may occur. Each of the one hundred divisions of the graduated button represents a movement of 1 micron.

Revolving Stage, 120 mm. in diameter, is covered with vulcanite; axis of revolution is 90 mm. from the arm. Provided with **Mechanical Stage,** buttons of which are on concentric axes; lateral movement 60 mm., to-and-fro movement 38 mm.

Sub-stage. May be moved up and down on its bearing by rack and pinion. The iris diaphragm beneath the condenser is located on one arm, which swings to the right and on which provision is made for **oblique light,** the decentering secured by rack and pinion. The condenser is of the drop swing type. The **upper iris diaphragm** is located on one arm which swings to the left. The **mirror** is mounted on a swing arm mounted independent of the stage.

5885 ——, with **Abbe Condenser** (N. A. 1.40), **16 and 4 mm. objectives,** and **10X ocular** giving magnifications of 100 and 440 diameters **$110.00**

5885A ——, same as above, but with **revolving dust-proof double nosepiece** **114.00**

5885B ——, with **Abbe Condenser** (N. A. 1.40), **16 and 4 mm. objectives** and **6X and 10X** oculars giving magnifications of 60, 100, 264 and 440 diameters **111.50**

5885C ——, same as above, but with **revolving dust-proof double nosepiece** **115.50**

5885D ——, with **Abbe Condenser** (N. A. 1.40), **16, 4 and 1.8 mm.** (oil immersion) **objectives,** with **revolving dust-proof triple nosepiece,** and **6X and 10X oculars** giving magnifications of 60, 100, 264, 440, 570 and 950 diameters **140.00**

No. 5890

No. 5890 Stage Removed

No. 5895

BINOCULAR MICROSCOPES, offered to meet the demands for a binocular instrument with wide range of adaptability.

Special Features:—Inclination Joint. Long Range. The inclination part carries a long slide which, when the microscope is erect, projects downward through the pillar and base until it nearly touches the table. **Removable Stage. Universal Mirror Adjustment.** Swings backward, forward and sidewise. **Can be used horizontally** to examine vertical objects. **Accommodation for any pupillary distance.** The light to either eye can be shut off by a shutter which automatically returns to central position. **Accurately paired objectives** and **oculars.**

5890 ——, with **40 mm. paired objectives** and **10X paired oculars** **$62.00**
5890A ——, with **48 and 32 mm. paired objectives** and **6X** and **10X oculars** **77.00**
5890B ——, with **55, 40 and 25 mm. paired objectives** and **4X, 6X and 10X oculars** **92.00**
5890C ——, with **55, 48, 32 and 25 mm. paired objectives** and **4X, 6X and 10X oculars** **104.00**
5890D ——, with **55, 48, 40, 32 and 25 mm. paired objectives** and **4X, 6X and 10X oculars** **116.00**

METALLURGICAL MICROSCOPES, suggested as inexpensive microscopes for metallurgical purposes. May also be used to advantage in Biological work.

Arm and **pillar** are of a shape to give a working radius of 85 mm. from optical axis to the arm. With inclination joint.

Top Fine Adjustment of lever type, very sensitive and accurate. One complete revolution of the shaft moves body tube ½ millimeter.

Stage, 120 mm. in diameter. The center is covered by a removable disc that may be racked up and down through a distance of 45 mm., or may be removed entirely to allow placing under the objective an object larger than could be accommodated otherwise.

Accessories. Included at prices below are the Vertical Illuminator No. **5971** described on page 460 and the small frame by which metals may be held with the polished side upwards.

5895 ——, with **16 and 4 mm. objectives** and **10X ocular** **$88.00**
5895A ——, same as above, but with **revolving dust-proof double nosepiece** **92.00**
5895B ——, with **16 and 4 mm. objectives** and **6X and 10X oculars** **89.50**
5895C ——, same as above, but with **revolving dust-proof double nosepiece** **93.50**
5895D ——, with **32, 16 and 4 mm. objectives,** with **revolving dust-proof triple nosepiece,** and **6X and 10X oculars** **98.00**

5905 DISSECTING MICROSCOPE, Regent's Type, complete with lens **1.95**

DISSECTING MICROSCOPE, BLOCK, with hollow center designed as a receptacle for dissecting tools and magnifiers. This is closed by a door hinged at the lower end. Heavy glass stage with a black and a white background for use beneath the stage.

5907 ——, with **9X Doublet Magnifier** giving a magnification of 9 diameters, equivalent focus 27.8 mm., working distance 15 mm. **$2.50**

5908 ——, with **6X and 12X Doublet Magnifiers** giving magnifications of 6 and 12 diameters, equivalent foci 41.6 and 20.8 mm. and working distances of 22 and 12 mm. respectively **3.25**

No. 5907 Back View

Nos. 5910 to 5910E

DISSECTING MICROSCOPE, rack and pinion focussing adjustment, stage 75 × 100 mm. Covered by a heavy polished glass plate with a black and a white background to fit beneath the plate. Metal hand rests; jointed lens carrier permits of use of lens on any part of the stage; plano-concave mirror 50 mm. in diameter. In handsome cabinet.

5910 ——, with **9X doublet magnifier,** magnification 9 diameters. Equivalent focus of 27.8 mm. and a working distance of 15 mm. **$9.00**

5910A ——, with **6X and 12X doublet magnifiers,** magnifications of 6 and 12 diameters. Equivalent foci of 41.6 and 20.8 mm. respectively, and working distance of 22 and 12 mm. respectively **9.75**

5910B ——, with **9X Triple Aplanat Magnifier,** magnification 9 diameters. Large flat field and great working distance, equivalent focus 27.8 mm., working distance 24.5 mm. **11.75**

5910C ——, with **6X and 12X Triple Aplanat Magnifiers** having magnifications of 6 and 12 diameters. Large flat fields and great working distances. Equivalent foci 41.6 and 20.8 mm. and working distances of 36.8 and 18.4 mm. respectively **15.25**

5910D ——, with **9X Veraplanat Magnifier,** giving magnification of 9 diameters. Most critical definition, large, clear and flat field and long working distance **14.25**

5910E ——, with **6X and 12X Veraplanat Magnifiers,** giving magnifications of 6 and 12 diameters. Most critical definitions, large, clear and flat fields and long working distances **20.25**

NOTE.—Following outfits do not include the metal hand rests illustrated.

METAL HAND RESTS, extra . . . . . Per Pair **.75**

DISSECTING MICROSCOPES, similar to above, but focussing is accomplished by means of the button at the side of the pillar.

5912 ——, with **9X doublet magnifier** giving a magnification of 9 diameters, equivalent focus 27.8 mm., working distance 15 mm. **$6.75**

5912A ——, with **6X and 12X Doublet Magnifiers,** giving magnifications of 6 and 12 diameters, equivalent foci 41.6 and 20.8 and working distances 22 and 12 mm. respectively **7.50**

5912B ——, with **9X Triple Aplanat Magnifier,** giving magnification of 9 diameters. Large flat field and long working distance, equivalent focus 27.8 mm., working distance 24.5 mm. **9.50**

5912C ——, with **6X and 12X Triple Aplanat Magnifiers,** giving magnifications of 6 and 12 diameters; exceptionally sharp definitions, large, clear and flat fields and long working distances. Equivalent foci 41.6 and 20.8 mm., working distances 36.8 and 18.4 mm. respectively **13.00**

NOTE.—The prices above do not include the Metal Hand Rests illustrated.

METAL HAND RESTS, extra . . . . . Per Pair **.75**

ACHROMATIC OBJECTIVES. These objectives are all corrected for a tube length of 160 mm. and for a cover glass thickness of 0.18 mm. They give a sharp critical definition to the edge of the field and at the same time give exceptional long working distance and unusual flatness of field. All objectives are made with the Society Screw furnished by the Royal Microscopical Society and are interchangeable with those of European manufacture. All objectives are mounted directly into the model and are thus unharmed when cleaned with a solvent.

16 mm.

4 mm.

1.8 mm.

No. 5952

No. 5953

Abbe Condenser and Mounting
Nos. 5960 to 5961

ACHROMATIC OBJECTIVES

Catalogue No.	Equivalent Focus		Num. Aperture	Working Distance*	Diam. of the † real field	Price	
	mm.	inches approx.		With 160 mm. tube length and 10x eye piece mm.	mm.	Fixed Mount.	Adjust. Mount.
5920	48	2	0.10	28.0	6.5	$ 4.00	
5921	40	1¾	0.10	28.0	6.3	4.00	
5922	32	1⅜	0.10	15.0	4.7	4.00	
	30–22	1⅜	. . .	25.0	15.0		$20.00
5924	variable	to ⅜/10	. . .	2.0	8.0		
5925	25	1	0.25	9.5	3.3	5.00	
5926	16	⅔	0.25	5.0	2.1	5.00	
5927	12	½	0.40	1.8	1.4	8.00	
5928	8	⅓	0.50	1.5	1.0	8.00	
5929	5	⅕	0.70	0.4	0.55	8.00	
5930	4	⅙	0.85	0.46	0.40	8.00	18.00
5931	3	⅛	0.85	0.26	0.30	8.00	18.00
5932	Water Im. 3	⅛	1.15	0.22	0.30	20.00	24.00
5933	Oil-Im. 1.8	1/14	1.30	0.13	0.20	27.00	
5934	Oil-Im. 1.5	1/16	1.30	0.10	0.14	40.00	

*Working distance is the distance between the front lens and cover glass.

†Real field is the distance of the circular area seen through the microscope and measured in the plane of the object.

HUYGHENIAN OCULARS. These oculars all fit the standard tube adopted by Royal Microscope Society and are interchangeable with those of European manufacture. The terms 4X, 6X, 8X, 10X, etc., designate the magnification based on the size of the image projected the distance of distinct vision, i. e., 250 mm. (10 inches).

5940 ——, **4X OCULAR,** equivalent focus, 62.5 mm. — 2½ inches $1.50
5941 ——, **5X OCULAR,** equivalent focus, 50 mm. — 2 inches 1.50
5942 ——, **6X OCULAR,** equivalent focus, 40 mm. — 1⅗ inches 1.50
5943 ——, **8X OCULAR,** equivalent focus, 30 mm. — 1⅕ inches 1.50
5944 ——, **10X OCULAR,** equivalent focus, 25 mm. — 1 inch 1.50
5945 ——, **12X OCULAR,** equivalent focus, 20 mm. — ⅘ inch 1.50

REVOLVING DUST-PROOF NOSEPIECE, most carefully made and greatest care exercised to see that they are perfectly centered and are strong enough to remain so. Neatly finished in alcohol-proof enamel, with the focal lengths of the objectives used neatly engraved on the edge of the revolving portion.

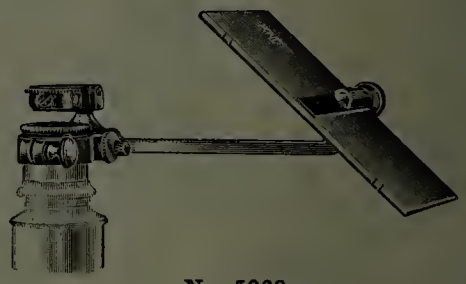
5952 **REVOLVING DUST-PROOF NOSEPIECE, double** $4.00
5953 ——, **triple** 5.50
5954 ——, **quadruple** 7.00

SUBSTAGE ABBE CONDENSERS. These are non-achromatic lenses mounted with an iris diaphragm beneath to modify the amount of light and with a ring beneath the iris to hold a blue glass for cutting out the yellow rays of artificial light.

5960 **ABBE CONDENSER, N. A. 1.20** $7.50
5961 **ABBE CONDENSER, N. A. 1.40** 9.00

MICROSCOPE ACCESSORIES

No. 5965



No. 5968

No. 5971

No. 5980

No. 5975

5965 BULL'S EYE CONDENSER, for illuminating opaque objects, etc. A plano-convex lens mounted on an adjustable stand. Diameter of lens 1½ inches **$4.75**

5966 ——, diameter of lens, 3 inches **6.00**

5968 ABBE CAMERA LUCIDA, showing the whole of the field, the object and the pencil point clearly. Prism so mounted that the opening in the silvering case can be lowered in the case of the higher power oculars or raised with the lower powers until it comes in the exact focus of the ocular. It can be so centered with one hand by two concentric screws, that the field is free from color to the extreme edge. The smoked glasses are so mounted around and below the prism that the light from the pencil and the object can be easily modified to make them equally distinct. The mirror (70 mm. × 105 mm.) is supported on an adjustable graduated bar. In mahogany case **20.00**

5969 ABBE CAMERA LUCIDA, similar to above, but the prism is permanently centered and there is no means of modifying the light from the ocular **10.00**

VERTICAL ILLUMINATORS. These instruments are constructed to screw into the nosepiece, between it and the objective. The light is directed into the opening in the side until it strikes the silvered surface from which it is reflected down through the objective to the object to be examined. It is then reflected back through the objective to the eye. The opening in the side is so arranged that it can be turned in any direction.

5971 ——, with silvered prism for reflecting the light. Prism is so mounted that it can be turned to reflect the light down through the objective as desired **6.50**

5972 ——, with silvered cover glass for reflecting the light. Provided with three openings of different sizes . **6.50**

5975 MECHANICAL STAGE, new construction, so made that the vernier reading designating the locations of objects taken on one microscope will register with the readings for the same objects taken on any other microscope. This feature is made possible from the fact that the vernier for the vertical movement and the arms holding the slide are adjustable. The stage will handle a slide 3 × 2 inches. Range 85 mm. lateral motion and 65 mm. vertical. In mahogany case **18.00**

5980 MICROSCOPE LAMP designed primarily for use with the dark field illuminator and vertical illuminator. This lamp serves most admirably as a lamp for general microscopic illumination. It works on any incandescent circuit, but must always be provided with a rheostat suitable for the voltage. Adjustments provided for moving the carbons and focussing the condenser, also for raising or lowering the height and angle of the lamp on its upright support. Provided with one blue and one ground glass plate, both of which fit into a groove in front of the condenser. Complete with five feet of Connecting Cord **14.00**

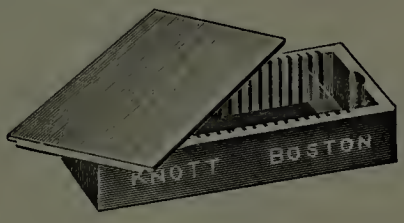
5980A FIXED RHEOSTAT for 110 volts—5 amperes **5.50**

5980B ——, for 220 volts—5 amperes **9.00**

5980C CARBONS for use in above lamp . . . . . Each **.05**

MICROSCOPIC SLIDES AND ACCESSORIES

No. 5990



No. 6010

No. 6000

No. 6005

No. 6014

COVER GLASSES

We have long been headquarters for the greatest variety of cover glasses, round, square or rectangular. Our stock, despite the shortage due to unusual conditions, is quite complete. We carry two thicknesses in stock, — No. 1 that varies from 0.11 to 0.17 millimeter thick, and No. 2, from 0.17 to 0.25 millimeter. **Specify** not only by **catalogue number,** but give also **shape, thickness number, size** and **quantity.**

CIRCULAR COVER GLASSES

	Thickness No.	Diameter	Per Fifty
5985A	1	15 mm. (⅝-inch)	$0.30
5985B	2	15 mm. (⅝-inch)	.30
5985C	1	12 mm. (½-inch)	.20
5985D	2	12 mm. (½-inch)	.20

5986 **COVER GLASSES, CIRCULAR,** 18 mm. (¾-inch) diameter . . . . . Per ½ ounce **$1.00**

RECTANGULAR COVER GLASSES

	Thickness No.	Dimensions	Per Fifty
5988A	1	15 × 15 mm.	$0.30
5988B	1	12 × 12 mm.	.20
5988C	2	12 × 12 mm.	.20
5988D	2	10 × 10 mm.	.18
5988E	1	32 × 32 mm.	1.00
5988F	1	35 × 35 mm.	1.35
5988G	1	22 × 40 mm.	1.30
5988H	2	22 × 40 mm.	1.30
5988I	1	15 × 45 mm.	1.10
5988J	2	15 × 45 mm.	1.10
5988K	1	36 × 50 mm.	2.50

5989 **COVER GLASSES, SQUARE,** 18 × 18 mm. (¾ × ¾-inch) . . . . . Per ½ Ounce **$1.00**

5990 **SLIDES, MICROSCOPIC, GLASS,** 3 × 1 inch, ground edges . . . . . Per Gross **1.68**

5992 **SLIDES, GLASS, concave centers** . . . . . Per Dozen **1.20**

5995 **LIFE SLIDE, HOLMAN'S,** a deep cylindrical cavity connected by a small channel with a more shallow beveled cavity. Complete with cover **1.35**

6000 **SLIDE BOX AND COVER, GLASS,** for use in staining sections. Width 2 5/16 inches, length 3 3/16 inches **.20**

STAINING JAR. See **JARS,** Page **451.**

6005 **TURN TABLE,** finely centered, all adjustments for preparing microscope slides **2.50**

6010 **SLIDE BOX,** of white wood, with closely fitting cover, grooved, to hold 25 slides, numbered and indexed **.10**

6012 **SLIDE BOX** for 100 slides. Covered with a heavy cloth. Hinged cover with two catches . . . . . **.40**

6013 **SLIDE BOX,** similar to above, but for 30 slides . . . . . **.35**

6014 **SLIDE CABINET, MINOT'S METAL,** a most compact fire-proof receptacle for storing slides. Constructed of metal throughout, neatly finished, inside and outside, with japan. Contains 30 japanned metal trays, each having a capacity for 24 slides. Each tray with knob and card holder. The cabinet is provided with brass lock. Size 36.5 cm. high, 32.5 cm. deep and 17.5 cm. wide, outside measurements.

Complete with 30 trays **20.00**

SLIDES, PREPARED MICROSCOPE MOUNTS

ZOOLOGY

6020 Knott's Prepared Microscope Mounts for Zoology:

a Skeleton of Commercial Sponge..... $0.50
b Transverse section of Sponge Grantia showing flesh and spicules..... .50
c Fresh Water Hydra, entire..... .60
d Transverse section of Fresh Water Hydra
Ectodern
Mesodern
Endodern..... .75
e Campanularian Hydroid (Obelia)..... .50
f Tubularian Hydroid (Pennaria)..... .50
g Transverse section of Sea Anemone (Metridium marginatum) showing plan of body structure of coral polyp..... .50
h Pedicellaria of Echinoderm (Starfish or Sea Urchin)..... .50
i Amœba..... 1.00
j Transverse section of Earthworm..... .50
k Circumœsophageal nerve ring and part of ventral nerve-cord of Earthworm..... 1.00
l Transverse section through heart of Clam... .50
m Transverse section through gill of Clam.... .60
n Mouth parts of biting Insect; Labrum, Mandibles, Maxillæ, Maxillary palpi, Labium, and Labial palpi..... .70
o Proboscis of House Fly..... .50
p Wing of Fly..... .50
q Spiracle of Cricket..... .50
r Tracheæ of Insect..... .50
s Scales on Wing of Moth..... .50
t Section through Compound Eye..... .55
u Gizzard of Cricket..... .50
v Mouth Parts of Honey Bee..... .65
w Blood of Fish..... .55
x Blood of Frog..... .55

6021 Price, complete set, as listed above..... 12.00

PHYSIOLOGY

6023 Knott's Prepared Microscope Mounts for Physiology:

a Blood, Human..... $0.70
b Blood, Frog, double stained..... .55
c Bone, longitudinal section, showing Haversian canals, canaliculi and lacunæ..... .80
d Bone, transverse section, showing Haversian systems, etc..... .80
e Cerebrum, section showing white and gray matter, etc..... .50
f Cerebellum, showing
1 Cortical layer of gray matter.
2 White matter of medulla, white medullary substance, the granule layer, the molecular stratum, and the layer of the cells of Purkinji..... .50
g Stomach, transverse section, showing the general arrangement of its coats
1 Mucosa containing tubular peptic glands and acid cells.
2 Sub-mucous coat.
3 Blood vessels.
4 Circular and longitudinal muscular layers.
5 Fibrous tunic covered with peritoneum..... .50
h Small intestine, transverse section, showing villi, unicellular glands, mucosa, etc..... .80
i Section of Spleen..... .60
j Adipose tissue..... .50
k Connective tissue..... .50
l Heart muscle, double stained, showing cross striations, nuclei, and characteristic branching of cardiac muscle cells..... .50
m Voluntary muscles, double stained, showing cross striations, nuclei sarcolemma, etc. .50
n Involuntary muscle, teased preparation, showing isolated muscle cells with nuclei..... .60
o Nerve Cells, from Cerebrum, showing protoplasmic processes and nuclei..... .50
p Cartilage, hyaline..... $0.50
q Spinal Cord, transverse section..... .50
r Large Intestine, double stained..... .55
s Sciatic Nerve, transverse section showing axis-cylinder, medullary substance, supporting connective tissue, etc..... .50
t Scalp, section of, showing hair, follicles, and sebaceous glands..... .70
u Skin, section of, showing sweat glands..... .70
v Lung, section of.. ..... .50
w Liver, section of, with blood vessels injected with red gelatin..... .55
x Kidney, section of, injected..... .55
y Retina of Eye, showing coats..... .80

6024 Price, complete set, as listed above..... 12.00

BOTANY

6026 Knott's Prepared Microscope Mounts for Botany:

a Longitudinal section of root tip of onion, showing
1 Root Cap.
2 Cell division and various karyokinetic nuclear stages..... $0.65
b Longitudinal section through apical cell of Nitella..... .80
c Cell formation by budding..... .50
d Spirogyra showing
1 Protoplasm and nucleus.
2 Chlorophyll bands..... .65
e Spirogyra in conjunction..... .55
f Spores of Corn Smut..... .50
g Mucor (black mould of bread)..... .50
h Section through archegonium of moss..... .75
i Section through antheridium of moss..... .75
j Peristome of moss (Polytricum)..... .50
k Prothallium of fern (Polypodium) showing
1 Reproductive organs.
2 Chlorophyll bodies..... .60
l Section through archegonium of fern prothallium..... .95
m Prothallium with young fern attached..... .80
n Transverse section of rhizome of fern (Pteris) showing
1 Closed concentric fibro-vascular bundles.
2 Scalariform vessels.
3 Parenchyma.
4 Parenchymatous sclerenchyma.
5 Prosenchymatous sclerenchyma..... .55
o Longitudinal section of n, showing 1, 2, 3, 4, 5, in longitudinal view..... .55
p Sporangin and Spores of Fern..... .50
q Longitudinal tangential section of wood of Pine showing cut ends of Medullary Rays .50
r Longitudinal Radial section of wood of Pine showing
1 Pitted tracheids.
2 Medullary rays..... .50
s Transverse section of vine stem showing first year's growth and arrangement of fibro-vascular bundles..... .50
t Tranverse section of wood of Pine..... .50
u Epidermis of leaf showing stomata..... .50
v Transverse section of leaf of Trillium..... .50
w Transverse section of ovary of Trillium.... .50
x Transverse section of stem of Indian Corn showing
1 Conjoint, collateral, closed vascular bundles.
2 Parenchyma.
3 Sclerenchyma..... .75
y Transverse section of exogenous stem showing
1 Cortex.
2 Camnium.
3 Rings of growth.
4 Pith.
5 Medullary rays..... .50

6027 Price, complete set, as listed above..... 12.00

SPECIAL MICROSCOPIC SLIDES

These slides are very valuable as indicating a wider range of structures than the previous sets. They will be found especially valuable to all teachers who are using or intend to use **THE NATIONAL BIOLOGY NOTE-BOOK.** To assist such teachers the numbers of the sheets in the note-book, in which slides are particularly useful, are indicated at the right.

6030 BOTANY.

a Spirogyra in Conjugation (B30)..... $0.75
b Conceptacles of Fucus (F10)..... .75
c Section of Cotyledon showing starch grains (F20) .50
d Section of Wheat (F21)..... .75
e Section of Oats (F21)..... .75
f Section of Nut (F21)..... .75
g Section of Pine (F21)..... .75
h Root-tip of Barley (F30)..... .65
i Root-tip of Dandelion (F30)..... .65
j Leaf-bud of Sycamore (F40)..... .65
k Flower-bud of Wallflower (F40)..... .65
l Flower-bud of Lily (F40)..... .65
m Section through Anther showing pollen chambers (low power) (F60)..... .65
n Varieties of Stamens showing methods of dehiscence (low power) (F60)..... 1.00
o Different types of Pollen Grains (low power) (F60)..... .65
p Cross-section of Simple Ovary showing ovules (low power) (F60)..... .65
q Sections of Compound Ovary showing types of placentæ (low power) (F60)..... 1.00

A Set of Bacteria Slides Showing:
r 1 Diplococcus (Y20)
s 2 Staphylococcus (Y20)
t 3 Streptococcus (Y20)
u 4 Bacillus (Tetanus with spores, an excellent type form) (Y20)
v 5 Comma Bacillus (Y20)
w 6 Streptobacillus (Y20)
x 7 Streptothrix (Y20)..... Complete set $7.00

6033 ZOOLOGY.

a Paramœcium (R11)..... 1.00
b Paramœcium in Conjugation (R11)..... 2.50
c Carchesium, double stained (R11)..... 2.00
d Mitosis in Protozoa (Opalina), beautiful slide with two large nuclei in Mitosis, triple stained. One of the most admirable specimens for showing the metotic cell division (R11)..... 2.50
e Hydra showing both reproductive organs (R11) 2.00
f Hydra showing ovary and bud (R11)..... 2.50
g Hydra showing bud (R11)..... 2.00
h Slides showing mitosis in Spermary (R 11)..... 2.50

We frequently have been requested to supply a series of slides particularly adapted to the requirements of schools which do not differentiate between the biological sciences. We offer, therefore, for those schools the following lists of slides selected as best adapted to a general biology course of Botany, Physiology and Zoology.

6035 GENERAL BIOLOGY COLLECTION, 40 Microscopic Slides selected to accompany a general course in Botany, Physiology and Zoology.

I **ALGÆ:**
Chlorophyceæ (Green Algæ)
Conjugales
a Spirogyra; (Conjunction and zygospores), V. T. of glyc..... $0.60

II **FUNGI**
Phycomycetes
b Mucor (or Rhizopus), zygospores.... .60

III **MUSCI (MOSSES)**
c Funaria, small plants with rhizoids, whole..... .50

IV **FILICALES**
Leptosporangiatæ
d Pteris, T. S. and L. S. of the rhizone.. .60

V **GYMNOSPERMÆ** (Gymnosperms, cyads, conifers, etc.)
Coniferales
Pinaceæ
Abietineæ
e Pinus, L. S. of the staminate cone.... .60
f Pinus, cross section of the leaf..... .50
g Pinus, Ra., Ta., and Tr. sections of the wood..... .60

VI **ANGIOSPERMS**
Stems
Monocotyledones
h Sea Mays, L. S. and T. S. general stem structure with collat. bundles..... .50
Leaves
Sections showing structure
i Lilium pardalinum, T. S. (general structure)..... .50
The Flower
Stamens, anthers, pollen, male gametophytes
j Lilium, T. S. of anther..... .60

VII **PROTOZOA**
Rhizopoda
Lobosa
k Amœba, 1st class..... 1.00

VIII **PORIFERA**
l Skeleton of Commercial Sponge..... .50

IX **CŒLENTERATA**
Hydrozoa
Leptolinæ
m Hydra, E..... .75
n Hydra, T. S..... .60

X **PLATYHELMINTHES**
Cestoda
o Tænia solium, proglottis, E..... $0.60

XI **NEMATHELMINTHES**
Nematoda
p Trichinella spiralis, in flesh..... .60

XII **ECHINODERMATA**
Echinoidea
q Echinus, pedicellaria..... .50

XIII **ANNULATA**
Chætopoda
Oligochæta
r Lumbricus, earthworm, T. S..... .50

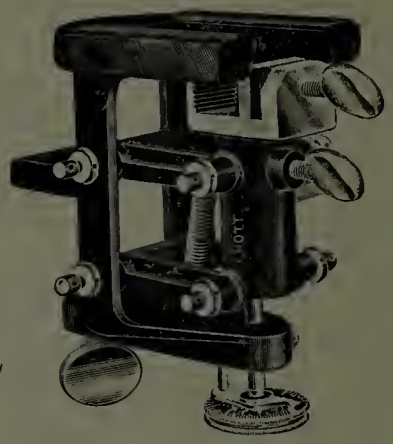
XIV **ARTHROPODA**
Insecta
Musca domestica (House Fly)
s Insect, proboscis..... .50
Lepidoptera
Bombyx (Silk Moth)
t Imago, scales..... .45
Coleoptera
Dytiscus marginalis (Water Beetle)
u Insect; trachea..... .60
v Insect; maxilla and palpus..... .60

XV **CHORDATA**
Mammalia
Cat Tissue, D. S.
w Cerebrum..... .60
x Duodenum, T. S..... .60
y Eye, retina..... .60
z Heart; cardiac muscle, striations, etc. .50
aa Liver..... .60
bb Lung; Alveolar structure, bronchi, etc .50
cc Muscle, voluntary, T. S. and L. S. .60
dd Nerve Cells, multipolar..... .60
ee Nerve fibers, medullated (Sciatic Nerve) .60
ff Pad of Toe..... .60
gg Stomach, T. S., Cardiac..... .60
hh Trachea, T. S..... .50
Rabbit Tissues, D. S.
ii Kidney, T. S..... .60
Ox Tissues
jj Ear; yellow elastic cartilage..... .60
kk Ligamentum nuchæ..... .60
HUMAN HISTOLOGY
ll Blood: leukæmia, D. S..... .50
mm Scalp: white..... .50
nn Skin: white, sweat glands, etc..... .50

6036 ——, complete set as listed above **$20.00**

6038 SLIDE MAKING MATERIAL. Teachers of Biology oftentimes have considerable difficulty in assembling material for mounting on slides. We have arranged for a careful selection of 50 packages of materials, diatoms, pollens, seed spores, parts of plants, insects, hairs, etc., etc., prepared especially for mounting. Per set of 50 packages **2.50**

No. 6040



No. 6042

No. 6046

6040 **MICROTOME, HAND.** The object is placed in a clamp in the upper end of the tube and is raised through the hole in the glass plate by an accurately cut screw which is entirely enclosed from dust and injury. The feed is accurate and finely graduated, each division representing 10 microns. The plate at the top is 3 inches in diameter and makes a firm support for the knife **$6.00**

6042 **MICROTOME, TABLE.** Can be readily attached by a screw clamp to the laboratory table or other support. Object clamp sets in a vertically moving socket held as illustrated. Feed regulated by micrometer screw with graduated disc and index plate. Glass surface plates provide traveling ways which are extra long, so that the knife will not be drawn off from the ends **12.50**

6043 ——, same as above, fitted with CO_2 Freezing Attachment No. **6069** **22.50**

6044 ——, same as No. **6042,** fitted with Ether Freezing Attachment No. **6067** **18.50**

MICROTOME, AUTOMATIC LABORATORY, for attaching to the edge of the table. The upper part of the casting of which the table clamp is a part is designed as a frame which forms a support for the laterally swinging arms which carry the knife holder. By an ingenious method of mounting this holder, the knife is given a movement which utilizes the entire length of the cutting edge, thus insuring uniform wear and permitting the cutting of large sections. Absolute uniformity of thickness in all sections is insured.

Feed secured by a vertical feed screw with fine micrometer thread. This feed screw is keyed to an accurately cut ratchet wheel in the teeth of which a hardened steel pawl engages. This pawl may be thrown out or may be set to cut sections of any desired thickness. Each division of the graduated scale marks 5 microns.

The drop pan beneath the object clamp may be removed if desired and it will be found desirable to remove it when the freezing chamber is attached.

6046 **MICROTOME, AUTOMATIC LABORATORY.** Complete with one knife and object clamp for paraffine or celloidin. In case **$45.00**

6047 ——, same as above, but fitted with CO_2 Freezing Attachment. (See No. **6069**) **55.00**

6048 ——, same as No. **6046,** but fitted with Ether Freezing Attachment. (See No. **6067**) **51.00**

No. 6050

ROTARY MICROTOME

New Construction

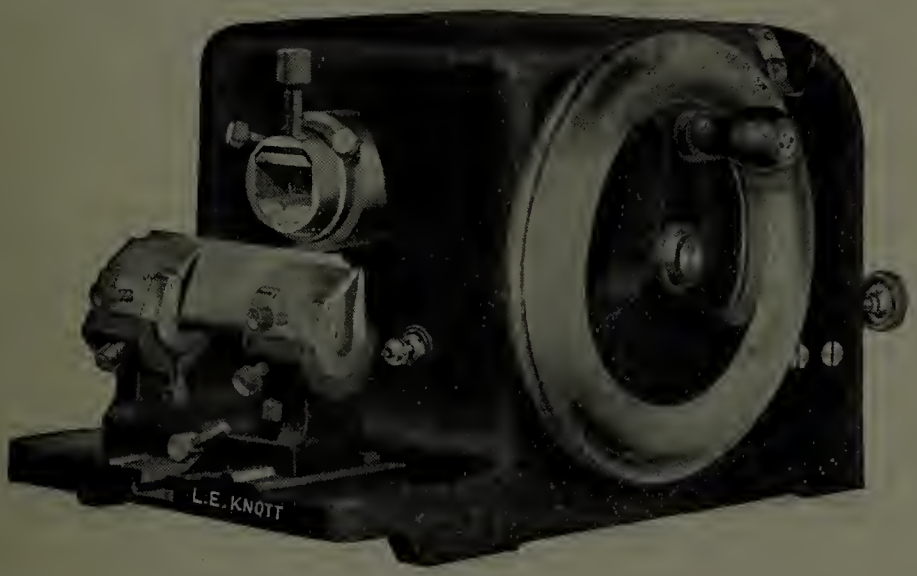
This microtome is the result of a most careful investigation of the requirements for a rotary microtome and a thorough study of the inaccuracies inherent in the earlier types. There are, in this new instrument, a number of points of advantage which will readily recommend themselves to the most exacting operator.

An accurate and reliable feed mechanism acting entirely independent of any inaccuracies due to the up and down movement of the object.

A modified escapement in connection with the ratchet wheel insures against momentum, — a cause for inaccuracy in the older models.

The feeding is done when the object is above the knife.

Feed adjustment is convenient and definite and may be set for any thickness from 1 micron to 60 microns.



No. 6050

Total excursion of the feed is 37 mm., — double that of most microtomes.

The feed pawl is automatically raised above the teeth on the return stroke and feeding is automatically stopped when the feed nut has reached its limit.

The adjusting of the object to the knife can be done more delicately than on any other microtome.

The object clamp is absolutely rigid, of great capacity and is most easily and carefully oriented.

An up and down stroke of 50 mm. is possible, — sufficient for cutting very large sections, also for cutting celloidin sections.

The knife may be attached at each end at the edge as well as at the back. These clamps may be moved towards one another to provide additional rigidity when desired and to permit using practically the whole of the cutting edge of the knife before resharpening.

The whole mechanism is covered dust-proof.

The microtome may be run by a motor.

With three object discs, one knife and handle and back for sharpening, all in case **$100.00**

6050A KNIFE HOLDER for **celloidin** sections . . . . . Extra **15.00**

6050B KNIFE for **paraffine sections** . . . . . Extra **5.00**

6050C KNIFE for **celloidin sections** Extra **$5.00**

6051 MOTOR with enclosed speed regulator, mounted on neat microtome table 38 × 26 inches. For 110 volts . . . . . Extra **60.00**

6052 ——, same as above, for 220 volts Extra **60.00**

6053 RIBBON CARRIER, an aluminum cylinder, 4½ inches long by 2⅝ inches diameter. It is mounted in an aluminum frame work under the base of which are little rollers rolling in the direction of the long dimension of the frame. The end of the ribbon adheres to the cylinder, which in use is slowly turned by the buttons as the ribbon lengthens. At the same time the cylinder and frame are gently pushed forward on the rollers to place the ribbon on the cylinder in the long spiral . . **$8.00**

No. 6053

MICROTOME ACCESSORIES

No. 6067

6067 **MICROTOME FREEZING ATTACHMENT FOR ETHER.** Consists of a freezing chamber of hard rubber which so prevents the radiation of the cold that the tissue is quickly frozen. The ether is held in a metal tank which for filling may be unscrewed from the support from which it is suspended. This attachment will freeze tissue 15 millimeters in diameter and 3 mm. thick in one minute, using only 5 cubic centimeters of ether $6.00

6069 **MICROTOME FREEZING ATTACHMENT FOR CARBON DIOXIDE,** for use on Microtomes Nos. **6042** and **6046.** The freezing chamber is provided with a pin like that on the object clamp which fits into the same socket on the microtome. The chamber is connected with the CO_2 chamber by a flexible copper tube. With this freezing attachment it is possible to cut, stain and mount a section ready for examination in one and one-half minutes from the time the tissue is put in the chamber. Complete with copper tube connections 10.00

Nos. 6073 to 6081 No. 6084

MICROTOME KNIVES. These knives are broad and heavy, steel most carefully selected, evenly tempered throughout their lengths. They are ground perfectly true so that when one is placed on an absolutely plane surface, the edge touches along its whole length, while the back does the same.

6073 ——, 50 mm. cutting edge $2.00
6074 ——, 110 mm. cutting edge 4.00
6075 ——, 120 mm. cutting edge 5.00
6076 ——, 185 mm. cutting edge 7.00
6077 ——, 240 mm. cutting edge, Wald make 8.75
6078 ——, 250 mm. cutting edge 12.00
6079 ——, 110 mm. cutting edge, ground especially for celloidin 5.00
6081 ——, 150 mm. cutting edge, with handle 4.75
6082 ——, special Wald make, 240 mm. cutting edge, curved metal shank 10.25

6084 **MICROTOME KNIFE HANDLE** for holding the knives while sharpening. Handles ebonized, metal parts finely nickel-plated 1.00

6085 **MICROTOME KNIFE BACKS.** In order that the knife may rest upon the honing stone at the proper angle when being sharpened, a special steel honing back has been designed. This slips ever the back of the knife $0.50

6088 **MICROTOME KNIFE STROP,** a flat piece of wood with a handle at one end. At one side of this strop is cemented a piece of leather 1¾ inches wide and 11 inches long, into which a very fine carborundum powder has been rubbed. The other side is covered by a very fine grade of leather for finishing 90

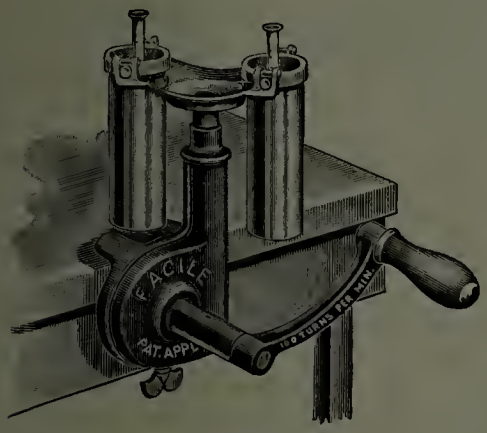
6090 **PITH** for **cutting sections** . . . . . Per Package .10

6092 **WARMING TABLE** for use in embedding objects in paraffine. Copper plate, 14 × 4 inches on stand 8½ inches high 1.50

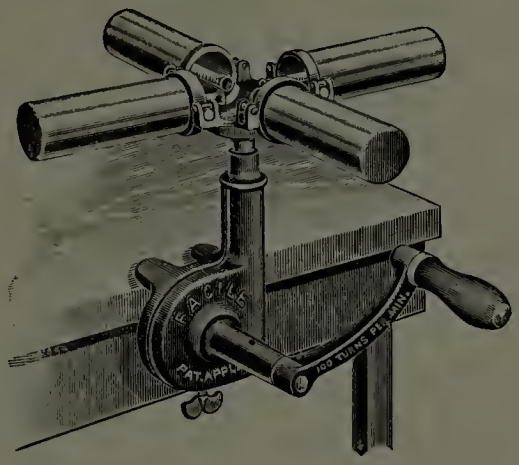
No. 6092

PARAFFINE BATHS. See **BATHS, PARAFFINE,** Page 409

MILK TESTING APPARATUS



No. 6100



No. 6102

6100 **HAND DRIVE TWO-BOTTLE BABCOCK MILK TESTER.** Consists of but two castings forming the gear case united at a ground joint, forming an air-tight gear case. Drive secured by one large steel gear and the steel vertical spindle which has spiral teeth directly milled into it.

Bottle carriers of heavily tinned malleable iron are removably attached to the top of the spindle. Rotating pockets are seamless brass.

Complete for milk testing, including test bottles, pipette, acid measure, test bottle brush, pint bottle of acid and full directions for making tests **$4.00**

6101 ——, with addition of cream test bottles, for making both milk and cream tests **4.50**

6102 **HAND DRIVE FOUR-BOTTLE BABCOCK MILK TESTER,** same as No. **6100,** but with bottle carrier for four bottles and four seamless brass pockets.

Complete with test bottles, pipette, acid measure, test bottle brush, pint bottle of acid, and full directions **5.00**

6103 ——, with addition of cream test bottles, for making tests for both milk and cream **5.50**

6105 **BABCOCK TEST TRAVELING OUTFIT.** Comprises No. **6102** Four-Bottle Babcock Milk Tester, 3 Babcock Full Milk Test Bottles, 2 Cream Test Bottles, 2 Double-neck Skim Milk Bottles, 1 Pipette, graduated for both milk and cream, 1 Test Bottle Brush, 1 Acid Measure, 1 small Quevenne Lactometer, 1 glass Thermometer, 1 bottle Testing Acid, all with full directions for making milk, cream and butter tests.

In hardwood Carrying Case with separate compartments for glassware and acid. Weight complete, 15¼ pounds **10.00**

6107 **HAND DRIVE ENCLOSED BABCOCK MILK TESTERS for 6-inch long test bottles.** Bottle carriers are solid malleable iron castings heavily tinned, swinging pockets of seamless brass with tinned malleable hangers. Solid cast iron case is 16 inches in diameter; cover split and hinged. Rotation is secured through a pair of steel worm or spiral gears and a pair of steel spur gears which are mounted on a separate frame detachably secured to the under side of the body.

These machines turn with remarkable ease and run with that smoothness and freedom from jar that are required to make an accurate test.

Prices include milk test bottles, pipette, acid measure, test bottle brush, pint of acid and full directions, all securely packed.

	a	b	c	d
No. of Bottles	6	8	10	12
Complete	**$9.00**	**10.00**	**12.00**	**14.00**

No. 6107d

Direct Connected

Motor-Belt-Driven

Nos. 6112a–d

6109 **MOTOR DRIVEN TWO-BOTTLE BABCOCK MILK TESTER,** for **6-inch long test bottles.** This machine consists of a 1/30 H. P. vertical spindle electric motor which carries directly on the extended spindle, the bottle carriers with swinging pockets.
Complete with regular equipment of glassware and sundries as ordinarily supplied. (When ordering state whether for D. C. or A. C. and voltage. If A. C., state also the number of cycles and phases) . **$35.00**

6110 **MOTOR DRIVEN FOUR-BOTTLE BABCOCK MILK TESTER,** same as above, but with four bottle carriers and necessary extra glassware and sundries **36.00**

6112 **MOTOR DRIVEN ENCLOSED BABCOCK MILK TESTERS, direct connected, for 6-inch long test bottles.** In these machines the motor has a vertical shaft on which the bottle carrier is directly mounted. This brings the motor underneath the machine. In this construction the weight of the bottle carrier and its load of bottles is, of course, directly on the motor. The **motor belt driven style,** while not so compact, will be found the most desirable, all things considered.
When ordering, **specify style desired,** also **whether for A. C. or D. C. circuits and voltage.** If A. C., state number of cycles.

	a	b	c	d
No. of Bottles	6	8	10	12
Complete, Direct Connected Type or Motor-Belt Driven	**$49.00**	**50.00**	**52.00**	**54.00**

No. 6115 No. 6123 No. 6125 No. 6130 No. 6132 No. 6136 No. 6139 No. 6141½ No. 6145 No. 6147 No. 6160

6115 **CREAM TEST BOTTLES, 6-inch, 9-gram,** 30 per cent. × ½ per cent. . . . . Per Dozen **$2.60**
6118 **CREAM TEST BOTTLES, 6-inch, 18-gram,** 30 per cent. × ½ per cent. . . . . Per Dozen **2.20**
6119 ——, 40 per cent. × ½ per cent. . . . . Per Dozen **2.40**
6120 ——, 50 per cent. × ½ per cent. . . . . Per Dozen **2.60**
6123 **MILK TEST BOTTLES, 6-inch, 18-gram,** 10 per cent. × 1/5 per cent. . . . . Per Dozen **1.70**
6125 **SKIM MILK TEST BOTTLE.** Gives readings down to one hundredth, each space representing five hundredths or 1/20 per cent. fat . . . . . **.60**
3803 **TEST BOTTLE BRUSH** for cleaning Babcock bottles . . . . . **.20**

6130 **ACID BURETTES** in 17.5 cc. divisions.

	a	b	c	d
No. of Charges	3	6	12	25
Each	**$2.00**	**2.00**	**2.50**	**3.00**

6132 **CREAMOMETER JAR,** 12 × 2 inches, graduated 0-30 and M or PM . . . . . **.50**
6134 **FUNNEL, ACID,** for filling milk and cream test bottles with acid . . . . . **.12**
6136 **LACTOMETER, SPENCE'S,** New York Board of Health pattern; 0° to 120° by 2° divisions **1.00**
6137 **LACTOMETER, QUEVENNE'S.** Scale 15° to 40° by single degrees. Sp. gr. Scale 1.015 to 1.040 **1.00**
6139 **ACID MEASURE,** 17.5 cc. . . . . **.15**
6141 **ACID PIPETTE,** accurately graduated, 17.6 cc. . . . . **.15**
6142 ——, accurately graduated, 18 cc. . . . . **.15**
6143 ——, combined graduated, with two marks, 17.6 and 18 cc. . . . . **.25**
6145 **AUTOMATIC PIPETTE.** To operate, squeeze rubber bulb, then insert point of pipette in milk, release bulb and the pipette fills, the overflow going into the large glass bulb **2.00**
6147 **IMPROVED PIPETTE.** By suction milk is drawn up until it is above the glass top, the stopcock is then closed and the measured milk is put in the test bottle **2.40**
6150 **BICHROMATE POTASSIUM TABLETS** for preserving composite test samples . . . . . Per 50 **.25**
6151 **CORROSIVE SUBLIMATE TABLETS** for preserving and coloring samples . . . . . Per 50 **.25**
6152 **FARRINGTON'S ALKALINE TABLETS** for determining the degree of acidity of milk, cream or whey . . . . . Per 50 **.25**
6155 **RICHMOND'S SLIDE RULE** for determining total solids in milk. With full directions for use . . **3.50**
6160 **FLOATING DAIRY THERMOMETER,** 8 inches long . . . . . **.50**

MINERAL COLLECTIONS

6170 **WASHINGTON SCHOOL COLLECTION, 20 Minerals, 20 Rocks,** in clothboard case, printed label list on lid . . . . . Per Set $2.50

6171 **HARDNESS COLLECTION, 9 specimens,** each in tray, all in oak box. With small diamond Per Set 2.75

6172 **SPECIFIC GRAVITY COLLECTION, 25 specimens,** large size, in improved trays . . . . Per Set 22.50

6173 **LUSTER COLLECTION, 16 specimens,** large size, in improved trays . . . . . Per Set 9.75

6174 **MISCELLANEOUS COLLECTION, 16 specimens,** selected especially to show Play of Colors, Change of Colors, Opalescence, Iridescence, Tarnish, Asterism, Schillerization, Fluorescence, Phosphorescence. Large size specimens, in improved trays . . . . . Per Set 18.25

6175 **FUSIBILITY COLLECTION, 6 specimens,** large size, in improved trays . . . . . Per Set 2.75

6176 **COLLECTION ILLUSTRATING TASTE, ODOR AND FEEL, 20 specimens,** large size, in improved trays . . . . . Per Set 9.50

6177 **BLOWPIPE COLLECTION, 50 most important species,** each in tray, all in oak box . . . Per Set 4.50

6178 **NEW YORK STATE PHYSICAL GEOGRAPHY COLLECTION, 64 specimens,** each in tray, all in pine box . . . . . Per Set 2.50

6179 **COLLECTION OF SOILS, 20 specimens,** each in quarter-pint glass show bottle, then in improved trays . . . . . Per Set 9.00

6180 **COLLECTION OF FUELS AND USEFUL HYDRO-CARBONS** (with Associated Rocks and Fossils), **40 specimens,** extra large size, in improved trays . . . . . Per Set 22.50

6181 **ORES OF GOLD, SILVER, PLATINUM AND IRIDIUM, 50 specimens,** each in tray, all in oak case . . . . . Per Set 19.75

6182 **COPPER ORES AND MINERALS, 50 specimens,** each in tray, all in oak case . . . . . Per Set 9.50

6183 **IRON ORES AND MINERALS, 50 specimens,** each in tray, all in oak case . . . . . Per Set 5.75

6184 **ORES AND MINERALS OF THE LEAD AND ZINC GROUPS (Lead, Tin, Zinc, Cadmium and Mercury), 60 specimens,** each in tray, all in oak case . . . . . Per Set 10.00

6185 **ORES AND MINERALS OF METALS USED FOR ALLOYING STEEL (Chromium, Cobalt, Manganese, Molybdenum, Nickel, Titanium, Tungsten and Vanadium), 50 specimens,** each in tray, all in oak case . . . . . Per Set 12.50

6186 **ORES AND MINERALS OF THE ALUMINUM AND MAGNESIUM GROUPS. (Aluminum, Barium, Calcium, Magnesium and Strontium), 50 specimens,** each in tray, all in oak case . . . . . Per Set 3.75

6187 **ORES AND MINERALS OF THE ALKALI METALS** (Cæsium, Lithium, Sodium, and Potassium), **25 specimens,** each in tray, all in oak case . . . . . Per Set 2.75

6188 **ORES AND MINERALS OF THE NON-METALLIC AND SEMI-METALLIC ELEMENTS (Arsenic, Antimony, Bismuth, Boron, Carbon, Selenium, Silicon, Sulphur and Tellurium), 50 specimens,** each in tray, all in oak case . . . . . Per Set 9.75

6189 **ORES AND MINERALS CONTAINING THE RARE EARTH ELEMENTS (Beryllium, Cerium, Didymium, Erbium, Lanthanum, Niobium, Scandium, Tantalum, Thorium, Uranium, Yttrium, and Zirconium), 72 specimens,** each in tray, all in oak case . . . . . Per Set 22.75

6190 **ROUGH PRECIOUS AND SEMI-PRECIOUS STONES, 25 specimens,** each in tray, all in oak case . . . . . Per Set 9.25

6191 **MISCELLANEOUS NON-METALLIC ECONOMIC MINERALS, 50 specimens,** each in tray, all in oak case . . . . . Per Set 4.75

MODELS — PHYSIOLOGICAL

ENLARGED SIZES—NATURAL COLORS

6200 **HUMAN HEART:** The anterior wall may be removed, exposing the four cavities of the heart, and their openings and valves $8.00

6201 **HUMAN EYE:** The upper portion, containing a microscopical representation of the layers of the retina, can be removed, when the cornea and the iris, the lens and the vitreous body may be taken out 6.50

6202 **HUMAN EAR:** Separates into parts, showing the membrana tympani, the ossicles of the tympanum, the labyrinth and the half-opened cochlea 7.00

6203 **HUMAN SKIN:** Transverse section, showing the organs of perspiration, a hair and its follicles, the pulp, sebaceous glands and tactile corpuscles 3.50

6204 **HUMAN TEETH:** The anterior portion of the left maxillary bone is removed to show the development and structure of the teeth 3.50

6205 **HUMAN BRAIN:** Four views:

a View of upper portion 3.25

b View of the lower portion (basis of cerebral nerves) 3.25

c View of perpendicular section along the median line 3.25

d View of transverse section of the head, showing the cavities 3.25

6206 **HUMAN HEAD:** Three Views:

a Head with muscles, nerves and blood vessels of one side 5.50

b Cavities of skull and eye, upper and lower jaw 5.50

c View of perpendicular section of the head, showing the brain, cavities of the mouth and nose, and the larynx and pharynx divided along the median line 5.50

6207 **HUMAN LUNGS,** with the heart in normal position:

a Anterior view of the lungs and heart. The pericardium opens and the anterior portion of the left lung may be removed, showing the bronchial ramifications, aveoli, etc. 4.50

b Posterior view of the lungs and heart, with a representation of the bronchial ramifications, air cells, blood vessels and lobuli 4.50

6208 **ORGANS OF RESPIRATION, AIR PASSAGES, LUNGS AND HEART:** The anterior part of both lungs and heart removes, laying open the lungs and showing the ramifications of the windpipe, and the connection of the pulmonary blood vessels with the heart 11.00

Continued on Next Page.

PHYSIOLOGICAL MODELS—Continued

6209 HUMAN LARYNX: Anterior and posterior views:
- a Is an anterior aspect, showing base of tongue, hyoid bone, thyroid gland, etc. **$2.75**
- b Posterior aspect, showing the glottis and vocal cords **2.75**
- c Larynx in connection with the tongue and pharynx, the latter is opened from behind, and parts showing mucous membrane **3.25**

6210 HUMAN JOINTS: Partially opened, showing their bones and ligaments:
- a Arm-joint of the shoulder, opened **2.50**
- b Elbow-joint, a, anterior view **2.00**
- c Elbow-joint, b, lateral view **2.00**
- d Wrist-joint and hand **2.75**
- e Hip-joint **2.50**
- f Knee-joint **2.50**
- g Ankle-joints and foot **3.50**

6211 HUMAN TRUNK (Torso), with viscera of the chest and abdomen laid open **32.50**

6212 HUMAN SKULL AND BRAINS, the various parts of which can be taken out **11.00**

6213 LARYNX PHANTOM, mask of the face with mouth open **9.50**

6215 PHYSIOLOGICAL MODELS. Set Complete, 28 models as above listed **125.00**

No. 6222

No. 6224

No. 6226

6220 MORTARS, PRESSED GLASS, with pestles.

	a	b	c	d
Capacity, ounces	2	4	8	16
Diameter, inches	2¾	4	4½	5
Each	**$0.22**	**.28**	**.35**	**.60**

6222 MORTARS AND PESTLES, IRON, urn shape.

	a	b	c
Capacity, pints	1	2	4
Each	**$0.50**	**.80**	**1.10**

6224 MORTARS AND PESTLES, PORCELAIN, with porcelain pestles.

	a	b	c	d
Diameter, inches	2¼	4	5½	7
Each	**$0.33**	**.48**	**1.00**	**1.25**

6226 MORTAR, of chilled steel, pestle 15 mm. diameter **$2.00**

MOUNTING PAPER. See **PAPER, MOUNTING,** Page **472.**

6235 MUFFLES, FUSED SILICA. (See index, **"Fused Silica Ware,"** for characteristics.) Highly refractory, will not crack with sudden and extreme changes of temperature, absolutely gas tight.
For assaying, ash determinations, ignition of precipitates, and general analytical and chemical work, they are unequalled. Especially valuable for enamelling small work, hardening and annealing small parts and for general testing and experimental use.

	a	b	c	d	e	f
Length, outside, inches	4½	6½	9½	7⅛	9½	18¼
Width, outside, inches	2⅝	4⅜	5⅞	4¾	6⅛	6⅝
Height, inches	2⅜	3½	5	2¾	4½	5
Each	**$1.85**	**2.50**	**4.25**	**2.50**	**3.75**	**6.75**

MUSEUM JARS. See **JARS, MUSEUM,** Page **451.**

6245 NEEDLE, INOCULATING, platinum point sealed in glass handle **$0.50**

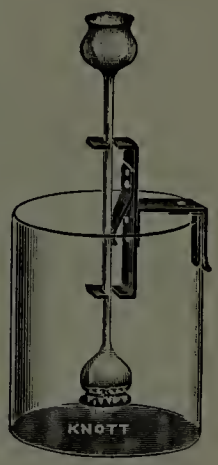
NEEDLES, DISSECTING. See Page **433.**

6945 NESSLER'S JARS OR TUBES for ammonia tests in water analyses; of colorless glass.

	a	b	c
Graduated, cc.	50	100	50 & 100
Each	**$0.65**	**.80**	**.95**

No. 6255

No. 6256



No. 20–215

No. 6295

6248 **OIL STONE,** high grade, an excellent stone for scalpels $0.35

6255 **OIL TESTER, Cleveland Open Fire Tester,** for high grade lubricating oils. Made of very heavy copper and brass casting, nickel-plated 14.00

6256 **OIL TESTER, ELLIOT'S, POLISHED COPPER** for flash point determinations, adopted as standard by the states of New York, New Jersey, Iowa, Michigan, and in general use everywhere . . 9.00

20–215 **OSMOSIS APPARATUS, STUDENTS',** for qualitative as well as quantitative work in osmosis. The apparatus consists of an osmosis tube of design as illustrated, held adjustably in a nickel-plated clamp which may be clamped to the side of a jar. One end of the osmosis tube is closed by a thin porous membrane which may be removed and replaced from time to time as needed.
Apparatus complete as illustrated 1.25

6268 **OVERSLEEVES,** Chemical and Water-proof, ample in size, readily adjusted to both sexes. Per Pair .40

5134 **PANS, AGATE WARE.**

	a	b	c
Dimensions, inches	6⅛ × 1½	7 × 1⅝	8½ × 2
Capacity, quarts	½	1	2
Each	$0.16	.18	.22

6280 **PAPER, SAND.**

	a	b	c
	Fine	Medium	Medium Coarse
Per Dozen Sheets	$0.18	.18	.18

PAPER, FILTER. See **FILTER PAPER,** Page **437.**

6285 **PAPER, GLAZED,** for use in laboratory, in color reactions.

	a	b	c
Color	White	Black	Blue
Per Quire	$0.30	.30	.30

5780 **PAPER, LITMUS, red,** in sheets . . . . . Per Sheet $0.04 Per Quire $0.66

5781 **PAPER, LITMUS, red,** in books of strips . . . . . Per Book .06

5782 **PAPER, LITMUS, blue,** in sheets . . . . . Per Sheet $0.04 Per Quire .66

5783 **PAPER, LITMUS, blue,** in books of strips . . . . . Per Book .06

6290 **PAPER, PARCHMENT,** best grade of vegetable parchment . . . . . Per Sheet .06

6990 **PAPER, TUMERIC** . . . . . Per Sheet $0.04 Per Quire .66

6292 **PENCIL, INDELIBLE,** for marking glass utensils 22

5789 **PENCIL, LITMUS** 25

PETRI DISHES. See **DISHES,** Page **432.**

6295 **PETRI DISH HOLDER, POLISHED COPPER,** with Inside Tray to lift out. Size 9 inches high by 4½ inches diameter 3.50

PINCHCOCKS. See **CLAMPS,** Page **423.**

6300 **PINS, INSECT, special, double japanned black,** finely tempered steel, needle points, absolutely fast heads.

	a	b	c	d	e	f	g	h	i
Size No.	00	0	1	2	3	4	5	6	7
Per 100	$0.20	.20	.18	.18	.18	.18	.18	.18	.18

6301 **PINS, INSECT, special, double plated white steel pins,** finely tempered steel, needle points, absolutely fast heads.

	a	b	c	d	e	f	g	h	i
Size No.	00	0	1	2	3	4	5	6	7
Per 100	$0.25	.25	.20	.20	.20	.20	.20	.20	.20

6302 **PINS, INSECT,** wth yellow heads, **japanned steel pins,** needle points, absolutely fast heads.

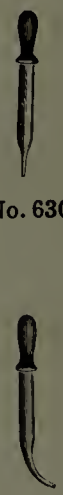
	a	b	c	d	e	f	g	h	i
Size No.	00	0	1	2	3	4	5	6	7
Per 100	$0.18	.18	.15	.15	.15	.15	.15	.15	.15

6303 **PINS, INSECT, INDESTRUCTIBLE, non-corrosive** metal, needle points, absolutely fast heads. Guaranteed not to corrode under the most trying conditions.

	a	b	c	d	e	f	g	h	i
Size No.	00	0	1	2	3	4	5	6	7
Per 100	$0.30	.30	.25	.25	.25	.25	.35	.35	.35

6305 **PIPES, CLAY** . . . . . Per Dozen $0.16

No. 6312 No. 6313



No. 6308

No. 6309

No. 6322

No. 6314

No. 6317

6308 **PIPETTES, Medicine Droppers,** straight tubes with pure rubber bulbs. Per Dozen **$0.35**
6309 ——, bent tubes with pure rubber bulbs . . . . . Per Dozen **.35**
6312 **PIPETTES, MOHR'S,** accurately graduated.

	a	b	c	d	e	f
Capacity, cc.	1 × 1/100	2 × 1/10	10 × 1/10	20 × 1/10	25 × 1/10	50 × 1/10
Each	**$0.35**	**.30**	**.44**	**.55**	**.62**	**1.00**

6313 **PIPETTES, VOLUMETRIC,** accurately graduated with one mark.

	a	b	c	d	e	f	g	h	i	j	k
Capacity, cc.	1	2	3	5	10	15	20	25	50	75	100
Each	**$0.09**	**.10**	**.12**	**.13**	**.17**	**.21**	**.22**	**.27**	**.33**	**.40**	**.45**

6314 **PIPETTES, VOLUMETRIC WITH STAND,** a set of above pipettes, 1, 2, 5, 10, 25, 50 and 100 cc., with improved stand . . . . . Set **$3.60**
6317 **PIPETTES, OVERFLOW, AUTOMATIC,** with patent three way stopcock and reservoir for collecting the excess liquid. Capacity 25 cubic centimeters **3.25**
6318 ——, capacity 100 cubic centimeters **3.85**
6090 **PITH** for cutting sections . . . . . Per Package **.10**
6322 **PLANT PRESS.** This press is a simple contrivance by which a plant is dried in a few hours without the troublesome changing of blotters and shifting of specimens. Consists of a series of layers of tubular paper inserted between sheets of blotting paper and absorbent cotton so that all the moisture is carried off by a current of hot air passing through the tubes. Size 9 × 12 inches **1.65**
6322A ——, size 12 × 19 inches **2.95**
6323 **MOUNTING PAPER,** 11 × 17 inches . . . . . Per Quire **.50**
6324 **DRYING PAPER,** 11 × 17 inches . . . . . Per Quire **.30**
6325 **GENUS COVERS** for mounting specimens; 11½ × 17½ inches when folded . . . . . Per Quire **1.00**
6327 **PLATES, FILTER, ALUNDUM,** for filtering where a small amount of solid matter is present in a large amount of liquid. May also be used for filtering dust from air or flue gases. Porosity 43.9 per cent. carried in stock. Porosity 47.4 per cent. may also be obtained on application. 60° bevelled edge.

	a	b	c	d
Inches	3/4 × 1/16	1 × 1/16	2 × 3/32	3 × 1/8
Each	**$0.28**	**.30**	**.40**	**.60**

No. 6334

6330 **PLATES, GLASS** for covers of bottles, beakers, etc.

	a	b	c
Size, inches	4 × 4	5 × 5	6 × 6
Each	**$0.03**	**.04**	**.05**

6332 **PLATES, GLASS, blue cobalt glass.** 2 × 4 inches **$0.07**
6332a ——, 4 × 4 inches . . . . . **.12**
6334 **PLATE, PORCELAIN, glazed,** 11 × 9 centimeters, with twelve cavities for color reactions **$0.75**
6336 **PLATE, PORCELAIN, unglazed** and **porous** for drying crystals. 22½ cm. diameter . . . . . **.16**
6337 **PLATE, STREAK, unglazed porcelain,** 6½ × 5 centimeters, for arsenic test, etc. . . . . **.30**
6339 **PLATES, PORCELAIN, porous, square,** for drying crystals and precipitates. 10 mm. thick, size 6 × 6 inches . . . . . **.25**
6340 ——, same as above, but 8 × 8 inches . . . . . **.55**
6342 **PLATES, PERFORATED GLAZED PORCELAIN,** for use in funnels.

	a	b	c
Diameter, mm.	25	38	50
Each	**$0.15**	**.20**	**.25**

6345 **PLATES, FUSED SILICA, UNGLAZED.** (See index, **"Fused Silica Ware,"** for characteristics.)

	a	b	c	d	e
Thickness, inch	1/10–1/8	3/16	1/4	3/8	1/2
Per Square Inch	**$0.03**	**.05**	**.06**	**.07**	**.08**

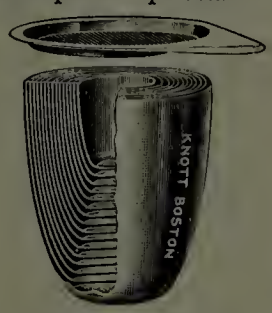
6346 **PLATES, FUSED SILICA, GLAZED,** 1/16–1/8 inch thick, in plates up to 6 inches square. Per Square Inch **.08**

PLATINUM WARE

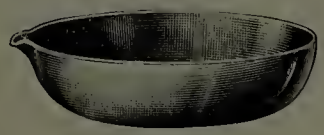
All of the following ware is hammered to shape, tested and finished in the best manner. It is guaranteed free from flaws and blisters and to give entire satisfaction in competent hands. Approximate weights are given without price. **Prices will be governed by the market price of platinum.**

Nos. 6364a-e

Nos. 6361a-g



Nos. 6363a-k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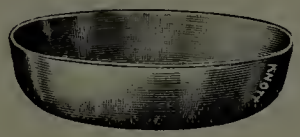

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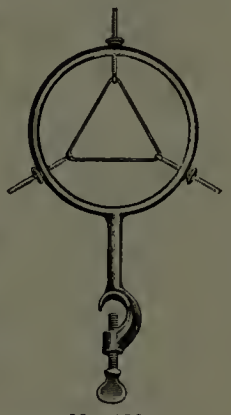
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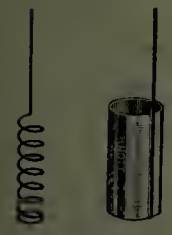
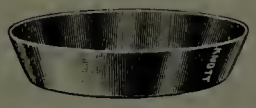

No. 6355 No. 6357

No. 6380



No. 6369

No. 6373

No. 6370

No. 6375

6350 PLATINUM FOIL.

	Light	Medium	Heavy
Thickness, inch	.001	.002	.0035
Thickness, mm.	.03	.05	.09
Approximate Weight per Square Inch	0.353	0.705	1.058

2 PLATINUM WIRE. Platinum loops for chemical laboratory work are usually made of No. 28 Wire, platinum triangles of Nos. 24 or 26, platinum inoculating needles of No. 24 and sometimes of No. 20.

B. & S. Gauge No.	18	20	22	24	25	26	28	30	32
Diameter, inch	.0403	.0319	.0253	.0201	.0179	.0159	.0126	.01	.0079
Diameter, mm.		.81	.64	.51	.45	.40	.32	.26	.20
Weight per Foot, grams	5.365	3.404	2.081	1.330	1.077	0.851	0.480	0.332	0.213

6355 PLATINUM ANODE, spiral ⅝ inch in diameter, made of .040 inch wire, 6½ turns, weight approximately 7 grams. This is the standard form and designed particularly for use with Cathode No. **6357** following.

6357 PLATINUM CATHODE, diameter of cylinder 1 inch, height 2 inches, height of stem 2 inches, height over all 4 inches. Diameter of stem .040 inch. Approximate weight 11 grams.

6361 PLATINUM FILTER CONES, seamless, 60°, perforations .016 to .025 inch.

	a	b	c	d	e	f	g
Diameter, inches	¾	⅞	1	1¼	1½	1¾	2
Approximate Weight, grams	1	1.5	2.1	3.1	5.3	7.5	9.2

6363 PLATINUM CRUCIBLES WITH COVERS. A crucible with cover weighs approximately as many grams as it holds cubic centimeters.

	a	b	c	d	e	f	g	h	i	j	k
Diameter, cm.	2.2	2.5	3.0	3.3	3.5	4.0	4.2	4.4	4.7	5.0	5.3
Depth, cm.	2.2	2.5	3.0	3.3	3.5	4.0	4.2	4.4	4.7	5.0	5.3
Capacity, cc.	8	10	15	20	25	30	40	50	60	70	80
Approximate Weight, grams	8	10	15	20	25	30	40	50	62	65	68

6364 PLATINUM CRUCIBLES, GOOCH, WITH COVERS.

	a	b	c	d	e
Diameter, cm.	2.7	3.2	3.3	3.6	3.9
Depth, cm.	2.7	3.2	3.3	3.6	3.9
Capacity, cc.	10	15	20	25	30
Approximate Weight, grams	13	18	22	29	34

6366 PLATINUM DISHES, round bottom, with lip.

	a	b	c	d	e	f	g	h	i	j	k	l
Diameter, cm.	3.8	4.2	4.4	4.8	5.6	6.5	6.5	7.2	7.8	8.4	8.9	9.4
Depth, cm.	1.0	2.0	2.2	2.4	2.7	3.0	3.3	3.5	3.7	3.7	4.1	4.3
Capacity, cc.	15	20	25	35	50	65	75	100	125	150	175	200
Approximate Weight, grams	5	6	8	12	17	22	25	33	42	50	55	67

6367 PLATINUM DISHES, without lip, a to l, same sizes and weights as above.

6368 PLATINUM DISH for **iron, steel** or **water analysis,** capacity 45 cc., approximate weight 15 grams.

6369 PLATINUM DISH for **milk analysis,** capacity 45 cc., approximate weight 17 grams.

6370 PLATINUM DISH for **sugar analysis.** Capacity 35 cc., approximate weight 16 grams.

6371 PLATINUM DISH for **water analysis.** Capacity 100 cc., approximate weight 20 grams.

6373 PLATINUM TIPPED FORCEPS for **blowpipe work** and general laboratory use.

6375 PLATINUM INCINERATING DISHES.

	a	b
Capacity, cc.	15	20
Approximate Weight, grams	10	14

6377 PLATINUM SPATULAS.

	a	b
Length, cm.	7	10
Approximate Weight, grams	5	8

6379 PLATINUM TRIANGLES, solid ends

	a	b	c	d	e	f
For Crucible, Capacity cc.	10	15	20	30	40	60
Size of Wire, inch	.045	.045	.055	.055	.064	.064
Weight in Grams	5	8	11	12	15	18

6380 PLATINUM TRIANGLES, twisted ends

	a	b	c	d	e	f
For Crucible, Capacity cc.	10	15	20	30	40	60
Size of Wire, inch	.045	.045	.055	.055	.064	.064
Weight in Grams	5	6	11	12	18	20

6381 PLATINUM TRIANGLES WITH HOLDERS, holders nickel-plated and will accommodate any size triangle for holding crucible up to 100 cc.

	a	b	c	d	e	f	g	h
For Crucible, Capacity cc.	10	15	20	30	40	60	80	100
Size of Wire, inch	.047	.047	.050	.050	.062	.062	.064	.064
Weight in Grams	2	2.5	4.5	5	7 5	8	9	10

No. 6385

6385 PLIERS, SIDE CUTTING, good quality . . . . . Each **$0.40**

PNEUMATIC TROUGHS. See **TROUGHS, PNEUMATIC,** Page **489.**

6390 POROUS CUPS.

	a	b	c	d
Diameter, inches	1½	2	2½	3
Height, inches	3	4	5	7
Each	**$0.15**	**.20**	**.25**	**.30**

POTASH APPARATUS. See **BULBS, POTASH,** Page **419.**

PRESSES FOR CORKS. See Page **426.**

PRESSES FOR PLANTS. See Page **472.**

6395 PUMP, CARBOY, for pumping acid from a carboy through a siphon. A carboy inclinator is not always safe and requires considerable care when used. This carboy obviates all danger and will be found a most satisfactory method of readily transferring acid from carboy to bottles.
Complete **$5.00**

PYROMETERS

INDICATING METERS—THERMO-COUPLES

A Pyrometer of two essential parts,— the **Meter** which indicates or records the temperature and the **Thermo-Couple** which, on being placed in the heat to be measured, generates the electromotive force that actuates the meter.

We have listed below two different types of meters each of which can be obtained with different ranges and graduated in Fahrenheit or Centigrade divisions. We have also listed various types of thermo-couples. From among these listed it will be possible to select types and ranges suited to individual requirements. To insure getting the proper outfit, it is advisable to inform us in regard to the service for which it is to be used.

Nos. 6397 to 6400A

PORTABLE INDICATING METERS. These are the highest grade D'Arsonval type Milli-voltmeters designed especially for pyrometer work. They are very sensitive high-torque meters, provided with:

1 **Zero Temperature Adjustment** which insures that the meter indicates correctly regardless of the temperature of the surrounding media.

2 **Zero Adjustor** which is a simple device for setting the pointer to agree with the cold end temperature of the Thermo-couple.

3 **Resilient Pivot Mounting** which permits the utmost delicacy in adjustment of the movement and by protecting it from the effects of jars and vibrations, preserves its accuracy.

The case is of aluminum, finished in black enamel. Over all dimensions are 6¼ × 6 × 3 inches. Scales are 5½ inches.

FAHRENHEIT SCALES			CENTIGRADE SCALES		
Catalogue No.	Range	Degrees per Division	Catalogue No.	Range	Degrees per Division
6397	32–1000	10	**6397A**	0–550	5
6398	32–1500	20	**6398A**	0–800	10
6399	32–2000	20	**6399A**	0–1100	10
6400	32–2550	25	**6400A**	0–1400	20

Price, with any of the above standard scales **$38.00**

Nos. 6402 to 6405A

WALL INDICATING METERS. These meters are essentially the same as the Portable Meters above listed, except that they are designed with wall mounting. The cases are of aluminum, finished in black enamel. Diameter, 6 inches, depth 3½ inches. Scale arc, 5½ inches.

FAHRENHEIT SCALES			CENTIGRADE SCALES		
Catalogue No.	Range	Degrees per Division	Catalogue No.	Range	Degrees per Division
6402	32–1000	10	**6402A**	0–550	5
6403	32–1500	20	**6403A**	0–800	10
6404	32–2000	20	**6404A**	0–1100	10
6405	32–2550	25	**6405A**	0–1400	20

Price, with any of the above standard scales **$38.00**

6407 **THERMO-COUPLES.** These thermo-couples generate an electro-motive force five times greater than the costly platinum-rhodium couples, have a practically straight line temperature, — E. M. F. relation, are heavy in cross section and are inexpensive. No. 14 B. & S. Gauge elements; length of couple 3 feet.
Price includes handle and 10 feet of flexible leads.
For maximum temperature of 1000° F. (550° C.) **5.50**

6408 ——, for maximum temperature of 1500° F. (800° C.) **5.50**

6409 ——, for maximum temperature of 2000° F. (1100° C.) **5.50**
For **Extra Length Couples** add, ... Per Foot **.60**

6410 **THERMO-COUPLES,** same as above, but No. 8 B. & S. Gauge elements and with flexible leads 20 feet long.
For maximum temperature of 1000° F. (550° C.) **6.75**

6411 ——, for maximum temperature of 1500° F. (800° C.) **6.75**

6412 ——, for maximum temperature of 2000° F. (1100° C.) **6.75**

6413 ——, for maximum temperature of 2500° F. (1400° C.) **6.75**
For **Extra Length Couples** add . . . . . Per Foot **.85**

6414 **THERMO-COUPLES,** same as No. **6407** but No. 6 B. & S. Gauge elements and with flexible leads 20 feet long.
For maximum temperature of 2000° F. (1100° C.) **8.35**

6415 ——, for maximum temperature of 2500° F. (1400° C.) **8.35**
For **Extra Length Couples** add, ... Per Foot **1.50**

6420 **PYROMETER TUBES, ALUNDUM.** (See Index, **"Alundum Ware,"** for Characteristics.) Supplied in lengths of 8, 12, 18, 24, 27, 30, 36, and 39 inches. When ordering **Specify Catalogue Number,** Length, Bore, and Wall.

	a	b	c	d	e	f	g	h	i
Bore, inch	7/16	3/16	1/4	9/16	3/4	7/8	1	1 1/8	1 3/4
Wall, inch	1/8	3/32	1/8	3/16	1/4	1/4	1/4	7/16	1/4
Per inch	**$0.28**	**.34**	**.28**	**.28**	**.34**	**.34**	**.45**	**.45**	**.50**

6425 **RECALESCENT OUTFIT,** — a simple and reliable apparatus for determining the proper hardening temperatures of carbon steel (high carbon steels only). The apparatus consists of an **Electric Furnace,** a Pyrometer and a Rheostat for regulating the furnace temperature.
The operation is to clamp two small pieces of steel to the end of the thermo-couple, place them in the electric furnace and heat until the "recalescent" or "critical" point is passed as indicated by the pyrometer.
Outfit complete with Electric Furnace No. **5482A** (see page **440**), for 110 or 220 Volts A. C. (60 cycles) or D. C. **$70.00**
NOTE. — When ordering, specify Line Voltage and whether A. C. or D. C.

No. 6425

PYKNOMETERS. See **BOTTLES, SPECIFIC GRAVITY,** Page **418.**

RADIOGRAPHS

No. 6430f

The following list of **RADIOGRAPHS** has been carefully made from the complete selection of one of our large hospitals, for the purpose of showing, first, the possibilities of correct X-Ray examination and, second, to show the formation of joints in the study of Physiology.

6430 FORMATION OF JOINTS. (a) Child's Hand, showing Epiphysis; (b) Adult Hand; (c) Elbow Joint (Lateral view); (d) Hip Joint; (e) Knee (Lateral view); (f) Ankle (Lateral view).

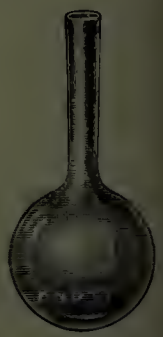
6431 FRACTURES AND FOREIGN BODIES. (a) Hand (Fracture Metacarpal Bones); (b) Fore Arm (Fracture Ulna and Radius); (c) Leg (Fracture Tibia and Fibular); (d) Hand with Needle Embedded; (e) Wrist (Typical Fracture); (f) Foot (Fractured Metatarsal).

Each . . . . . **$1.00** Choice, any six **$5.50**
Complete Series, **Nos. 6430** and **6431** **10.00**

6432 RADIOGRAPHS. A selected list of various articles photographed on one plate to show the different degrees of radiability of diverse substances **1.75**

Nos. 6445a–c

Nos. 6446a–f



Nos. 6435a–c

6435 RECEIVERS, RETORT.

	a	b	c
Capacity, ounces	4	8	16
Each	**$0.10**	**.14**	**.20**

6440 RETORTS, COPPER, for generation of oxygen, etc.

	a	b	c	d
Capacity, ounces	8	16	32	64
Each	**$2.25**	**2.50**	**3.35**	**3.95**

6445 RETORTS, GLASS, plain, without tubulations and glass stoppers.

	a	b	c
Capacity, ounces	8	16	32
Each	. . .	. . .	. . .

6446 RETORTS, GLASS with glass stoppers ground in.

	a	b	c	d	e	f
Capacity, ounces	4	8	16	32	48	64
Each	. . .	. . .	. . .	. . .	. . .	. . .

6448 RETORTS, IRON, for distilling mercury, etc.

	a	b	c
Capacity, ounces	8	16	32
Each	**$2.25**	**2.50**	**2.95**

6450 RETORTS, VITRIFIED PORCELAIN, with tubulature and stopper.

	a	b	c
Capacity, cc.	140	210	275
Each	**$2.50**	**4.00**	**4.35**

6460 RINGS FOR RING STANDS, Harcourt Open Side Filter Rings, short shank for use on small and medium stands.

	a	b	c
Diameter, inches	2	3	4
Each	**$0.13**	**.16**	**.20**

6461 RINGS FOR RING STANDS, Harcourt Open Side Filter Rings, long shank for use on large stands.

	a	b	c	d
Diameter, inches	2	3	4	5
Each	**$0.14**	**.17**	**.21**	**.25**

Nos. 6460a–c

6463 RINGS FOR RING STANDS, short shanks for use on small and medium stands.

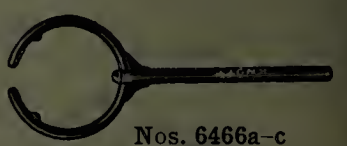
	a	b	c
Diameter, inches	2	3	4
Each	**$0.10**	**.13**	**.16**

6464 RINGS FOR RING STANDS, long shank for use on large stands.

	a	b	c	d
Diameter, inches	2	3	4	5
Each	**$0.12**	**.15**	**.18**	**.20**

6466 EXTENSION RINGS, OPEN SIDE (Harcourt Open Side Filter Rings). Require the use of Clamp Holder No. **4011.**

	a	b	c
Diameter, inches	2	3	4
Each	**$0.13**	**.15**	**.18**



Nos. 6466a–c

6468 RINGS, EXTENSION, for use with No. **4011** Clamp Holder.

	a	b	c
Diameter, inches	2	3	4
Each	**$0.11**	**.13**	**.15**

6472 RINGS, CONCENTRIC, of cast iron, japanned, with **clamp** for use on ring or retort stands, to support funnels, flasks, etc.

	a	b
No. of rings	3	4
Diameter of Largest Ring, inches	6	8
Set	**$0.70**	**.90**

Nos. 6472b

6480 **RODS, GLASS,** in lengths of one meter.

	a	b	c	d
Diameter, mm.	4	5	6	7
Per Pound	$0.50	.50	.50	.50

6482 **RODS, GLASS, Stirring Rods,** finished ends.

	a	b
Size, mm.	5 × 150	6 × 150
Per Dozen	$0.16	.20

6484 **RODS, FUSED SILICA.** (See index, **"Fused Silica Ware,"** for characteristics.) Can be used for stirring and pouring at high temperatures, particularly in the case of high melting metals and alloys which do not form basic oxides. In lengths up to 6 feet.

	a	b	c	d	e	f
Diameter, inch	1/16	1/8	3/16	1/4	5/16	3/8
Per Foot	$0.40	.50	.75	1.00	1.25	1.40

No. 6490

6486 **RUBBER BANDS,** assorted sizes . . . . . Per Box $0.15

43-220 **RUBBER DAM,** thin sheet rubber, best quality . . . . . Per Square Foot .33

RUBBER DISCS, a tough sheet rubber especially selected for foot bellows.

Catalogue Number	3702	3702A	3702B
Diameter, inches	9 1/8	11 1/4	14 1/4
Each	$0.95	1.35	1.95

6490 **RUBBER POLICEMEN** for scraping precipitates from the sides of beakers, etc. For use on glass rods. Pure rubber, without glass rod . . . . . Each .08

THE KNOTT QUALITY
ANTIMONY RUBBER TUBING AND STOPPERS

We early realized that the reason why France, Germany and England were supplying practically all of the rubber tubing and stoppers used in chemical laboratory work, was due to research devoted to this branch of chemical industry. We, therefore, secured the services of chemists eminently well fitted to undertake this line of work, in order to find out the reason why rubber of equal quality could not be produced in this country. These researches resulted in our well-known Formula "317," on which our laboratory rubber for the past sixteen years has been based.

Many laboratories have not yet appreciated the fact that cheap rubber is, in the end, the more expensive. Both economy and efficiency in laboratory organization make it eminently desirable to use the best rubber obtainable. In ordering, specify Knott's "317" Antimony Rubber, and thus be sure of obtaining a rubber of the highest quality.

6500 **KNOTT'S "317" ANTIMONY RUBBER TUBING,** regular thickness of wall, extraordinary quality.

Inside diameter, inch	1/8	3/16	1/4	5/16	3/8	1/2	3/4
Price per Foot	$0.06	.08	.12	.15	.17	.26	.40

6502 **KNOTT'S "317" ANTIMONY RUBBER TUBING,** same quality as above, but extra thickness to withstand pressures.

Inside Diameter, inch	1/8	3/16	1/4	5/16
Price per Foot	$0.10	.18	.20	.25

6510 **FLEXIBLE STEEL GAS TUBING,** for gas supply, connections to hot plates, gas stoves, gas burners, etc. This tubing is practically indestructible, is gas tight and will not kink. Inside diameter 1/4-inch, and carried in stock in two and three-foot lengths only, each length with rubber ends for connecting to gas cock and burner nipples.

	a	b
Length, feet	2	3
Per Length	$0.22	.30

No. 6510

KNOTT'S "317"

ANTIMONY RUBBER STOPPERS

No. 6515

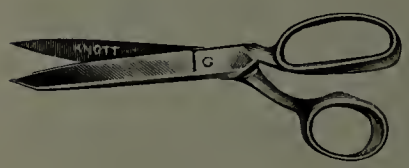
In order to simplify the method of determining the size of rubber stopper desired for a specific purpose, our stoppers are given a number corresponding to the small diameter in millimeters. Hence, the stopper K25 means a stopper 25 millimeters in diameter.

In ordering specify the number according to our list and insist on Formula "317" if you wish a stopper of the very highest grade.

We carry in stock rubber stoppers, solid, with one hole and with two holes as indicated below.

Size No.	Diameter Small End	Mean Diameter	Length		Price Per 100
K11	11 mm.	12 mm.	22 mm.	solid or 1 hole	$3.00
K13	13	15	22	solid or 1 hole	4.00
K15	15	17	25	solid, 1 or 2 holes	5.00
K17	17	19	25	solid, 1 or 2 holes	6.00
K19	19	21	25	solid, 1 or 2 holes	7.00
K21	21	23	25	solid, 1 or 2 holes	9.00
K23	23	25	30	solid, 1 or 2 holes	11.00
K25	25	28	30	solid, 1 or 2 holes	14.00
K28	28 mm.	30 mm.	30 mm.	solid, 1 or 2 holes	$15.00
K30	30	33	30	solid, 1 or 2 holes	20.00
K33	33	37	28	solid, 1 or 2 holes	23.00
K37	37	41	28	solid, 1 or 2 holes	31.00
K40	40	44	30	solid, 1 or 2 holes	40.00
K43	43	46	32	solid only	46.00
K47	47	50	32	solid only	48.00
K51	51	53	32	solid only	56.00

6516 **RUBBER STOPPER,** No. 1½ for Dr. Boles' Hospital Bottle as used at Boston City Hospital. Each **$0.36**

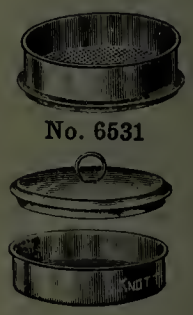


No. 6520

No. 6522

No. 6923

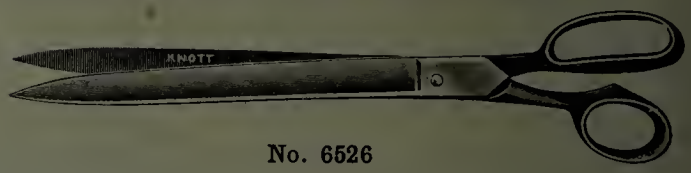
No. 6532



No. 6531

No. 6533

No. 6524



No. 6526

6923 **SACCHAROMETER, DR. EINHORN'S FERMENTATION,** with graduated test tube. With directions **$0.75**

6520 **SCISSORS,** for general utility, fine grade . . . . . **.65**

6522 **SCOOP, HORN,** 4 × 2⅛ inches . . . . . **.18**

6524 **SHEARS, METAL CUTTING,** cutting blade 2½ inches . . . . . **.75**

6526 **SHEARS, PAPER,** superior quality. Cutting blade 10 inches long **1.00**

6530 **SIEVES, SEAMLESS BRASS FRAMES, BRASS GAUZE,** substantially constructed for mixing or separating substances into different grades of fineness. These sieves are made so that one will nest with the other. Five inches diameter.

	a	b	c	d	e	f
Mesh	10	20	40	60	80	100
Each	**$1.20**	**1.25**	**1.35**	**1.45**	**1.55**	**1.70**

6531 **SIEVES, SEAMLESS, BRASS FRAMES, BRASS GAUZE,** same as above but 8 inches diameter.

	a	b	c	d	e	f
Mesh	10	20	40	60	80	100
Each	**$2.30**	**2.30**	**2.40**	**2.50**	**2.60**	**3.00**

6532 **SIEVES, SEAMLESS, BRASS FRAMES, BRASS GAUZE, nested,** 5 inches in diameter, 20, 40, 60, 80 and 100 mesh, with brass pan and cover. Same sieves as Nos. **6530b-f** . . . . . Per Set of Five **8.40**

6533 **SIEVES, SEAMLESS, BRASS FRAMES, BRASS GAUZE, nested,** 8 inches in diameter, 20, 40, 60 80 and 100 mesh, with brass pan and cover. Same sieves as Nos. **6531b-f.** . . Per Set of Five **14.50**

6535 **SIEVES, WOOD FRAME, BRASS GAUZE,** diameter 6 inches.

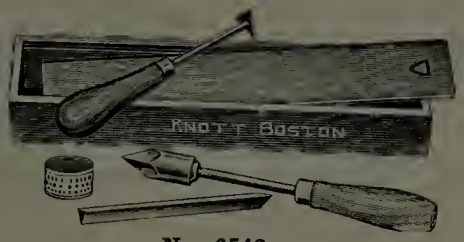
	a	b	c	d
Mesh	30	40	60	80
Each	**$0.70**	**.75**	**.85**	**1.00**

No. 6550

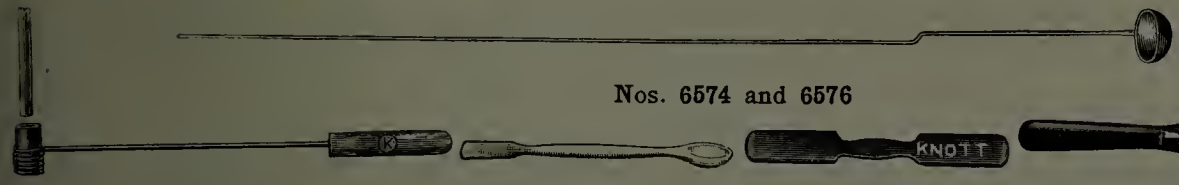
No. 6564

Nos. 6582a-c

No. 6578



No. 6542



Nos. 6574 and 6576

No. 6586

Nos. 6580a-c

No. 6560

No. 6562

32-200 **SIPHON, GLASS,** plain $0.20

32-205 **SIPHON WITH SUCTION TUBE,** glass 35

SLEEVES. See **OVERSLEEVES,** Page **471.**

6542 **SOLDERING OUTFIT.** Comprises one bar of solder, one box of resin, scraper and a special soldering copper of sufficient size to retain heat and designed so that it may either be heated as an ordinary soldering copper or, when attached to a gas burner, the gas will pass through a hollow tube within the length of the handle and is ignited at emission holes immediately beneath the copper. In wooden box 1.00

6543 **SOLDERING OUTFIT,** similar to above, except that the soldering copper is not adapted to a gas burner and is not quite so highly finished. In wood box 75

6544 **SOLDERING COPPER,** with handle, one-half pound size 60

6545 **SOLDER,** stick form . . . . . Per Pound .45

6546 **SOLDER, Wire Form** with **Resin Cutter.** No flux required . . . . . Per Pound .50

6547 **SOLDERING PASTE, ACID** . . . . . Box .25

6548 **SOLDERING FLUID, ACID** . . . . . Bottle .25

SOLDERING IRON, ELECTRIC. See **ELECTRIC APPLIANCES,** Page **436.**

6550 **SOLDERING IRON HEATER,** for coal gas, a necessity for the laboratory work room 1.50

6551 ——, same as above for gasoline gas 1.85

SOXHLET'S APPARATUS. See **EXTRACTION APPARATUS,** Page **436.**

6560 **SPATULAS, HORN,** double.

	a	b	c
Length, inches	4	5	6
Each	$0.12	.15	.19

6562 **SPATULA, RUBBER, OSTWALD'S.** This is a superior instrument and will be found practically indestructible 40

6564 **SPATULAS, STEEL** with **wood handle.** Flexible polished steel blade.

	a	b	c
Length, inches	3	4	6
Each	$0.22	.27	.40

SPECIMENS AND SPECIMEN MOUNTS. See Page **480.**

6570 **SPLINTS,** 100 in package, selected lengths . . . . . Per Package .15

6572 **SPONGES** for general laboratory use. These sponges are of excellent quality selected of convenient size and to give long service . . . . . Each .18

6574 **SPOONS, DEFLAGRATING,** of heavy iron, handles 16 inches long.

	a	b
Diameter of Spoons, inch	½	¾
Each	$0.08	.10

6576 **SPOONS, DEFLAGRATING,** of heavy brass, handles 16 inches long.

	a	b
Diameter of Spoons, inch	½	¾
Each	$0.12	.15

6578 **SPOON, HORN,** with Spatula End, length 5 inches 15

6580 **SPOONS, PORCELAIN** with **SPATULA END,** glazed.

	a	b	c
Length, mm.	110	150	170
Each	$0.20	.25	.30

6582 **SPATULAS, PORCELAIN,** with spatula on each end, glazed.

	a	b	c
Length, mm.	105	130	160
Each	$0.20	.25	.30

6586 **SPOON, SODIUM,** Sodium Capsule, after Brownlee and Others. With ramrod 3

Nos. 6610a-d

6610 SPECIMEN MOUNTS, KNOTT'S PROTECTED BOTANICAL. Consist of two parts, — a thin plate of photographic glass to which narrow flaps of linen morocco paper are neatly fastened, and a cardboard back to which is glued a thin layer of sterilized surgical cotton in which the specimens may be embedded.

	a	b	c	d
Size, inches	5 × 6	6½ × 8½	8 × 12	12 × 16
Each	**$0.24**	**.28**	**.42**	**.70**

6611 SPECIMEN MOUNTS, KNOTT'S PROTECTED ENTOMOLOGY, suitable for mounting and preserving specimens of butterflies, beetles and insects of all kinds, or of plants too large for Botanical mounts. Consist of two parts, — the mounting part a heavy cardboard tray lined with a heavy pad of cotton, and the cover, designed to fit dust-proof over the mounting part, is designed with a photographic glass top which permits of inspection of specimens. This cover portion is covered with black binding cloth.

	a	b	c	d	e	f	g	h
Size, inches	2½ × 3	3½ × 4½	4 × 5	5 × 6	6½ × 6½	6½ × 8½	8 × 12	12 × 16
Each	**$0.16**	**.18**	**.20**	**.24**	**.28**	**.36**	**.50**	**1.00**

SPECIMENS

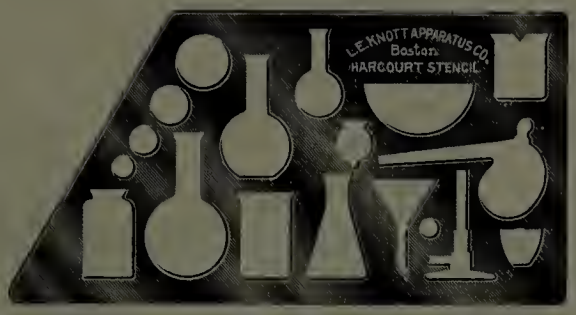
No. 6620

Much care has been expended on the preparation of our zoological material, so that it will be suitable for elementary courses. It is to be strongly recommended for its practical value. We try to keep live specimens and the prices are approximately the same as those of the preserved material

National Biology Sheet.	Each	Dozen	100
a — R10 — Amœba Microscopic Slides, specially prepared	**$1.00**	**$10.00**	**$75.00**
b — Z10 — Grantia (Simple Sponge)	**.10**	**.35**	**2.50**
c — Z20 — Hydra (fusca or viridis)	**.25**	**1.50**	**10.00**
d — Z21 — Metridium (Sea-anemone)	**.25**	**2.00**	**15.00**
e — — — Medusa of Obelia, slides stained. (Admirable for showing Medusa structure)	**.60**	**7.00**	
f — — — Medusa (Small, Gonionemus)	**.15**	**1.00**	**8.00**
g — — — Medusa (Large, Aurelia)	**.40**	**3.00**	**20.00**
h — — — Coral (Species) ?	**.10**	**.75**	**5.00**
i — Z30 — Earthworm (Lumbricus)	**.10**	**.75**	**5.00**
j — Z32 — Sandworm (Nereis viridis)	**.15**	**1.25**	**10.00**
The sandworms are killed and hardened by a special process which renders the tissues firm. They are admirably suited for dissection and the preparation of cross-sections. They are far superior to the ordinary formalin material.			
k — Z40 — Starfish (Asterias) medium size, dry or formalin	**.15**	**1.00**	**8.00**
l — — — Sea Urchin	**.15**	**1.00**	**8.00**
m — Z50 — Crayfish (Cambarus)	**.15**	**1.00**	**8.00**
n — Z52 — Lobster (Homarus) chicken	**.75**		
o — Z54 — Large Florida Grasshoppers	**.20**	**1.50**	**10.00**
These afford, in our opinion, the very best material for insect dissection. We solicit a trial order.			
p — — — Crickets	**.10**	**.75**	**5.00**
q — — — Roaches	**.10**	**.75**	**5.00**
r — — — Spider (Epeira)	**.10**	**.75**	**5.00**
s — Z60 — Clam (Mya)	**.05**	**.50**	**3.00**
t — — — Snail (Large European)	**.10**	**.75**	**5.00**
u — — — Chart of Mollusca	**1.50**		
v — — — Amphioxus	**.25**	**1.50**	**10.00**
w — — — Necturus	**.50**	**5.00**	
x — V21 — Frogs (very large)	**.50**	**5.00**	
y — — — Medium Size	**.20**	**2.00**	

6624 SCHOOL COLLECTION of 70 SPECIES OF INSECTS. Collection especially selected to represent all of the Principal Order. Complete Collection **5.00**

6630 STENCIL, HARCOURT IMPROVED. Consists of a flexible transparent plate with various "cut-outs" representing outlines of chemical utensils as illustrated. The ruling edges of the obtuse angle serves as convenient guides in drawing delivery tubes. One edge has a metric scale for dimensions. Recommended by prominent teachers of chemistry in that its use eliminates bad drawings, saves time, inspires the pupil, holds his attention and induces accurate thinking . . . . . Each $0.10
Per Dozen 1.00

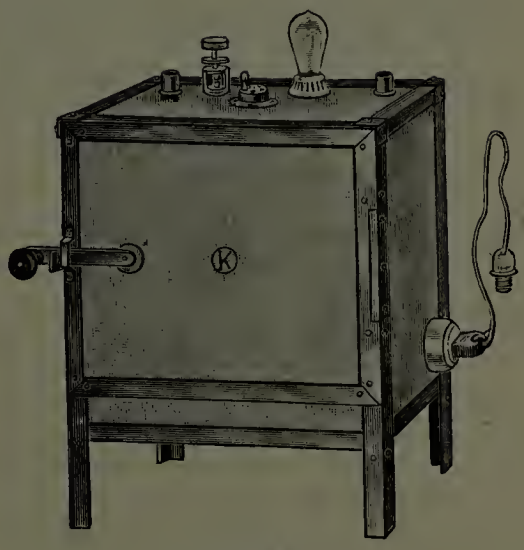


No. 6630

6631 STENCIL CUT-OUTS, three sizes Flat Bottom Flasks, Erlenmeyer Flask, Bottle, Plain Beaker, Griffin Beaker, Thistle Top, Funnel, Evaporating Dish, Bunsen Burner, Crucible and Retort. Of transparent material, same shapes and sizes as cut-outs of stencil illustrated above. Per Package of 13 Cut-outs $0.05

STERILIZERS

No. 6642



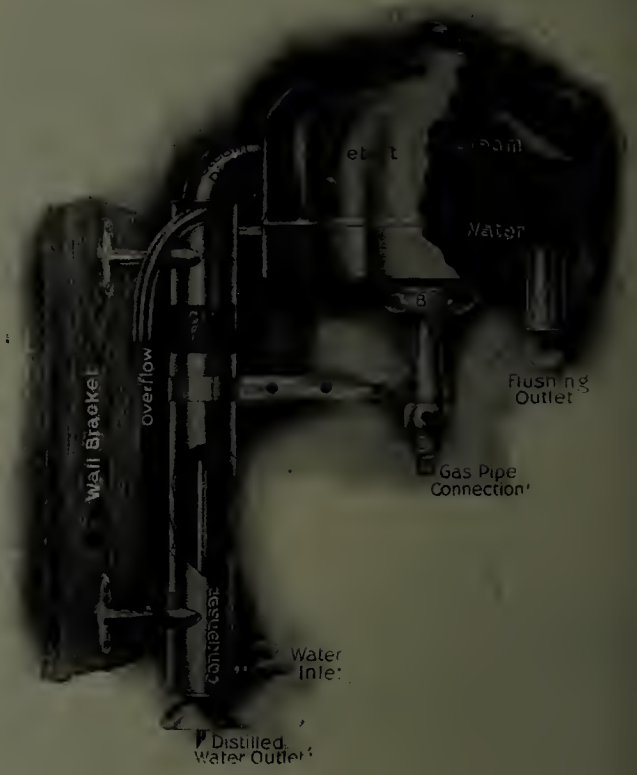
No. 6644

6640 STERILIZER, HOT AIR, of **sheet iron, double wall** with enclosed base and extra asbestos mat. Inside measurements, 10 inches high, 12 inches wide and 10 inches deep. Extreme height, including base, 21½ inches. With two shelves $27.00

6642 STERLIZER, HOT AIR, of **sheet iron, double wall,** outer wall **covered with asbestos.** Heated by a row of small Bunsen Burners around the sides of the base, insuring an even circulation of heat. The air is introduced through openings on each side. Inside dimensions, 19 inches high, 12 inches wide, 9½ inches deep. With three shelves 38.50

6644 STERILIZER, ELECTRIC, HOT AIR, automatic control. Constructed of asbestos board and with heavy brass binding. Range 50 to 200 degrees Centigrade; regulation positive and control within one degree. Consumption 5 amperes. All contact points are outside of the oven, thus eliminating any possible danger when using a combustible substance. Heating units are independent and can be renewed. Size 10 × 10 × 12 inches wide. Complete for 110 volts either D. C. or A. C. with 6 feet of cord and with plug for any ordinary socket 39.00

Nos. 62–70a-e



No. 62–80

62–70 STILLS (DISTILLING APPARATUS). Consists of a heavy copper, tin-lined still with removable head, connected with a pure block tin worm, enclosed in a zinc condensing vessel, having proper inlets and outlets.

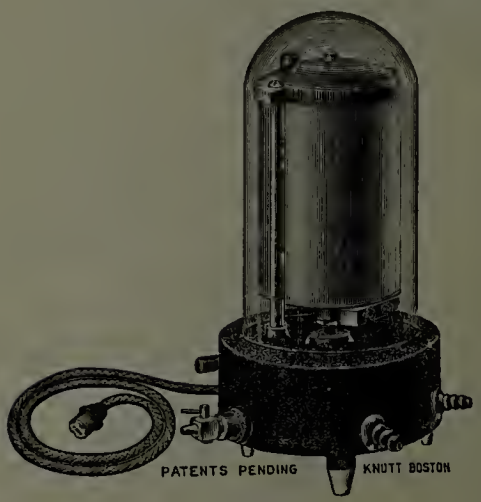
	a	b	c	d	e
Capacity, gallons	½	1	2	3	5
Still and Condenser	$10.60	12.40	14.50	19.75	26.50

6651 STILLS, only, of above outfit.

	a	b	c	d	e
Capacity, gallons	½	1	2	3	5
Each	$5.50	6.25	7.25	10.00	14.25

62–80 STILL, ACME. This still is a perfect apparatus for the production of pure water by distillation. The distillate is cold, and aerated if desired. The apparatus is of first-class workmanship throughout and is made of copper and brass, tin-lined and nickel-plated. The gas and water connections are extremely simple. The Acme Water Still runs automatically and there is nothing to get out of order. It is started and stopped in a moment. The "Acme" is comparatively the fastest and most economical Water Still, as it produces a gallon of distilled water in about 1½ hours, at a cost of about 1½ cents per gallon. It is the most durable still, and will practically last a life-time, as the mineral and other matter that remains in the retort is drained off through the flushing outlet, this being done in a moment without any trouble and without displacing the still or taking it to pieces. The combustion of gas with our special burner is perfect and all the heat is fully utilized. Wall space required 4 × 12 inches, extreme width 8 inches, projection 14 inches.

Still as illustrated with burner for coal or water gas, natural gas, or acetylene **$24.50**



No. 6655

6655 STILL, MERCURY, HARCOURT ECONOMY, for use on any 110 volt A. C. or D. C. circuit, ready for use as soon as filled and connected to lighting circuit current, automatically shut off when mercury in the retort is exhausted. Operating cost approximately one cent per pound of distilled mercury.

The impure mercury is vaporized in an iron retort surrounded by a heating unit having proper and ample electrical and heat insulation. This entire unit is surrounded with a polished metal casing which serves both to protect the insulation surrounding the heating unit and to prevent unproductive radiation.

The vaporized mercury passes down into the condensing chamber located in the base. This chamber is entirely surrounded by a water jacket in which a continuous stream of cold water is allowed to circulate. Complete condensation is produced and the clean distilled mercury is drawn off as desired through the steel spigot connected to the chamber.

The glass globe shown in the illustration and supplied with the instrument is not an essential feature, but is used as a precautionary measure to make doubly sure that no mercury fumes can possibly reach the room atmosphere **$14.00**

Nos. 6662a-c

No. 6660

No. 6664

No. 6665

No. 6667

No. 6668

STOPCOCKS, BRASS. See **KNOTT'S GAS COCKS**, Page **445**.

6660 **STOPCOCK, GLASS, FRESENIUS' FORM.** Bore one mm. . . . . Each **$1.25**

6662 **STOPCOCKS, GLASS, GEISSLER'S.** Straight cocks carefully ground in by hand.

	a	b	c
Diameter of Bore, inches	1	2	3
Each	**$0.95**	**1.20**	**1.40**

STORAGE BATTERY HYDROMETERS. See Page **448**.

6664 **STOVE, GAS,** top 12 × 12¾ inches, height 5 inches, finished in black, **drip pan, drawing out in front,** valves and supply pipes nickel plated and polished **4.50**

6665 ——, **two burners,** top 22½ × 12 inches, height 5 inches **6.50**

6667 **STOVE (HOT PLATE), ELECTRIC, ROUND.** Operates on 110 or 220 Volts A. C. (60 cycles) or D. C. Life of heating element guaranteed for one year.
Diameter, 6 inches, pressed steel top, heavy bent wire legs, "blued" steel finish. Boils one liter of water from cold in 15 minutes. Maximum temperature 483° C. (900° F.). Current consumption 500 watts. With 6 feet Twin Conductor Flexible Cord and detachable Connector Plug (110 or 220 volts A. C. or D. C.) **6.75**

6667A **EXTRA HEATING UNIT** for above **3.35**
NOTE.—When ordering **specify Line Voltage** and **whether A. C. or D. C.**

6668 **STOVE (HOT PLATE), ELECTRIC, SQUARE,** similar to above, but 12 inches square. Sheet steel top, cast iron legs, "blued" steel finish. Centrally heated by spiral resistance unit covering circular area 5¾ inches in diameter.
Maximum temperature at center, 260° C. (500° F.), temperature at edge 121° C. (250° F.). Current consumption 500 watts. With 6 feet Flexible Twin Cord and detachable Connector Plug **9.00**

6668A **EXTRA HEATING UNIT** for above **3.35**
NOTE.—When ordering **specify Line Voltage** and **whether A. C. or D. C.**

No. 6670

6670 STOVES (HOT PLATES), THREE HEAT ELECTRIC for use on 110 or 220 Volts A. C. (60 Cycles) or D. C.

Life of heating unit guaranteed for one year.

Sheet steel top and legs. "Blued steel" and black enamel finish.

Renewable resistance units composed of three parallel windings each connected by a snap switch on front of plate, heat distribution uniform. Low heat obtained with one switch on, medium, with two switches on, high heat, with three switches on. Low, 246° C. (475° F.); medium, 316° C. (600° F.); high, 399° C. (750° F.)

	a			b		
Size of Plate, inches	12 × 18			18 × 24		
	Low	Medium	High	Low	Medium	High
Current Consumption, watts	600	1200	1800	1200	2400	3600
Price, 110 or 220 Volts, A. C. or D. C.		**$30.50**			**47.00**	

NOTE. — When ordering specify Line Voltage and whether A. C. or D. C.

6671 EXTRA HEATING UNITS for above . . . . . Each **$11.25**

NOTE. — No. **6670a** requires one unit, but No. **6670b** requires two units.

STOVES, GAS. See also pages 200 to 202.

STROP. See **MICROTOME KNIFE STROP,** Page **466.**

No. 6679

No. 6687

No. 6681

No. 6685

No. 6689

SUGAR HYDROMETERS. See Nos. **5674A to C,** Page **448.**

6679 SUPPORT, FUNNEL, as designed at Harvard College. A strip of hardwood with four beveled holes for 60° funnels. A V-Clamp attached to the index side of this strip permits of attaching to the rods of supports Nos. **6691** and **6692** **$0.45**

6681 SUPPORT, FUNNEL, for 6 funnels. H Metal Base, metal upright rod, wood funnel holder, with clamp **1.95**

6681A WOOD FUNNEL HOLDER, as used on above stand **1.10**

6682 SUPPORT, FUNNEL, for 4 funnels **1.80**

6682A WOOD FUNNEL HOLDER, as used on above stand . . . . . **.95**

6683 SUPPORT, FUNNEL, for 2 funnels **1.70**

6683A WOOD FUNNEL HOLDER, as used on above stand . . . . . **.85**

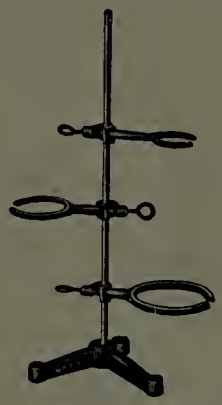
6685 SUPPORT, GAY-LUSSAC'S IMPROVED, of hardwood, cork-lined clamp with long ½-inch extension rod **1.25**

6687 SUPPORT, SCHELLBACH'S UNIVERSAL, of hardwood, cork-lined clamp with universal movement, height of clamp adjustable **1.33**

6689 SUPPORT, PIPETTE, REVOLVING, for 12 pipettes, of hardwood **2.20**

No. 6691

No. 6692


No. 6694b

No. 6695b

No. 6701

6691 SUPPORTS, RING OR RETORT, with **Rectangular Base** and **Rod.** Base of iron, neatly japanned, coppered steel rod.

	a Small	b Medium	c Large
Rod, inches	18	24	36
Rectangular Base and Rod	**$0.32**	**.42**	**.60**

6692 SUPPORTS, RING OR RETORT, with **Tripod Base** and **Rod.** Of iron, tripod japanned, rod coppered steel.

	a Small	b Medium	c Large
Rod, inches	18	24	36
With Tripod, each	**$0.30**	**.42**	**.58**

6694 SUPPORTS, RING OR RETORT with **HARCOURT OPEN SIDE FILTER RINGS.**

	a Small	b Medium	c Large
No. of Rings	2	3	4
Diameter of Rings, inches	2 & 3	2, 3 & 4	2, 3, 4 & 5
Rectangular Base, Rod and Rings	**$0.55**	**.75**	**.95**

6695 SUPPORTS, RING OR RETORT, with **HARCOURT OPEN SIDE FILTER RINGS.**

	a Small	b Medium	c Large
No. of Rings	2	3	4
Diameter of Rings, inches	2 & 3	2, 3 & 4	2, 3, 4 & 5
Tripod Base, Rod and Rings	**$0.52**	**.70**	**.90**

6697 SUPPORTS, RING OR RETORT with **RINGS.**

	a Small	b Medium	c Large
No. of Rings	2	3	4
Diameter of Rings, inches	2 & 3	2, 3 & 4	2, 3, 4 & 5
Rectangular Base, Rod and Rings	**$0.55**	**.75**	**.95**

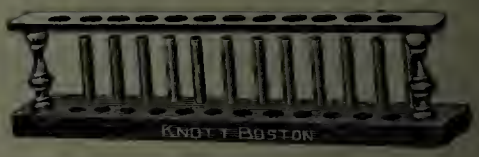
6699 SUPPORTS, RING OR RETORT WITH RINGS.

	a Small	b Medium	c Large
No. of Rings	2	3	4
Diameter of Rings	2 & 3	2, 3 & 4	2, 3, 4 & 5
Tripod Base, Rod and Rings	**$0.52**	**.70**	**.90**

6701 THE HARCOURT LECTURE TABLE RING STAND AND ATTACHMENTS.
Consists of extra large Ring Stand with 4 Clamp Holders, Universal Clamp No. **4000,** Condenser Clamp No. **4006,** Quick Acting Condenser Clamp No. **4013,** 3 Harcourt Open Side Rings, 2, 3 and 4-inch, Nos. **6460a** to **6460c,** 2 Harcourt Open Side Extension Rings, 3 and 4-inch, Nos. **6466b** and **6466c,** and Platform Support. Complete Outfit **$4.35**

No. 6710

No. 6711



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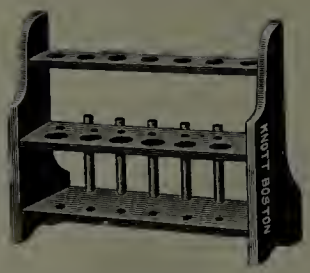

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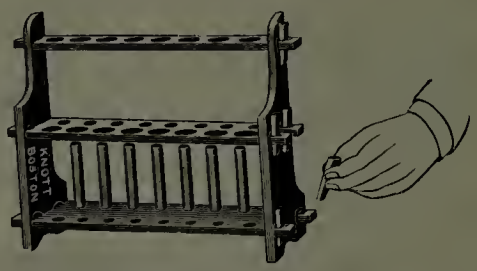
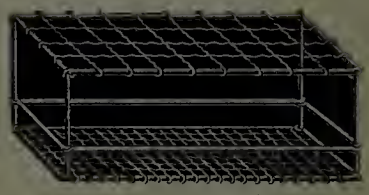


No. 6719

No. 6720

No. 6722



No. 6724

No. 6726

TEST TUBE SUPPORTS. Our test tube supports have this distinctive feature, — they will hold tubes one inch in diameter.

6710 **SUPPORT, TEST TUBE,** for 4 tubes, with 4 drying pins $0.22

6711 ——, for 6 tubes with 6 drying pins 25

6713 **SUPPORT, TEST TUBE,** for 12 tubes with 12 drying pins; 10 holes are $^{15}/_{16}$-inch diameter, 2 holes $1\frac{1}{8}$ inches diameter, with drain groove 42

6715 **SUPPORT, TEST TUBE,** for 13 tubes with drying pins 40

6717 **SUPPORT, TEST TUBE,** for 25 tubes, with drying pins 65

6719 **SUPPORT, KNOCKED DOWN TEST TUBE.** This support occupies a very small compass when packed for shipment. It is very readily assembled, offering a substantial support. For sixteen tubes with drying pins 50

6720 ——, same as above, for 25 tubes, with drying pins 85

6722 **SUPPORT, TEST TUBE AND FUNNEL,** after Irish for 8 tubes; with drying pins; two adjustable funnel supports 75

6724 **SUPPORT, TEST TUBE, WIRE,** galvanized iron wire rack for 36 test tubes $0.33

6726 **SUPPORT, TEST TUBE,** for drying tubes, with 50 drying pins 98

6727 ——, with 25 drying pins 85

6735 **SYRINGE, HYPERDERMIC, 1 to 25 minims.** The distinctive feature of this syringe is that the barrel is ground to fit the metal parts and the syringe may be dissembled for cleaning. With two steel needles in pasteboard box 1.25

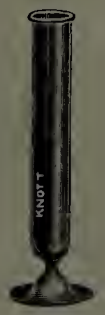
No. 6735

No. 5642

Nos. 6795a–h

No. 6800

No. 6802



No. 6804

No. 6806

5795 **TABLES, LOGARITHM,** a heavy board card, 14½ × 9½ inches. with four place tables of logariths and antilogariths, with table of atomic weights, also Factors for Analysis. Computed by Dr. Hubert G. Shaw. This card is of convenient size for students' use in the laboratory. Used extensively and for years at the Massachusetts Institute of Technology . . . . . Each **$0.35**

5642 **TEST GLASSES, on foot,** clear colorless glass.

	a	b
Capacity, ounces	2	4
Each	$0.40	.45

6795 **TEST TUBES,** colorless glass tubes of special glass, resistant to changes in temperature.

	a	b	c	d	e	f	g	h
Length, inches	4	4	5	5	6	6	6	8
Diameter, inches	½	⅝	⅝	¾	⅝	¾	1	1
Per Gross	$1.90	2.10	2.25	2.40	2.50	2.75	4.25	5.00

6798 **TEST TUBES, FUSED SILICA.** (See index, "Fused Silica Ware," for characteristics.) These test tubes are of great service in laboratory work. as they withstand high temperatures and can be cooled rapidly without breakage.

	a	b	c	d	e	f
Size, inches	4 × ½	5 × ½	5 × ⅝	6 × ⅝	6 × ¾	7 × ⅞
Each	$0.85	1.00	1.20	1.45	1.75	2.25

6800 **TEST TUBES, BOSTON BOARD OF HEALTH,** without flange, heavy wall, 5 inches long × ⅝-inch diameter . . . . . Per Gross **$3.70**

6802 **TEST TUBES WITH SIDE NECKS.**

	a	b	c
Length, inches	6	8	10
Each	$0.10	.12	.30

6804 **TEST TUBES ON FOOT,** colorless glass tubes on pedestal bases.

	a	b	c	d
Height, inches	4	5	6	8
Diameter, inches	½	⅝	¾	1
Each	$0.06	.08	.10	.20

6806 **TEST TUBES, GRADUATED.**

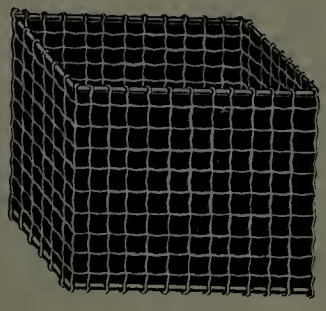
	a	b	c
Capacity, cc.	10	20	30
Graduated to cc.	1/10	1/10	1/10
Each	$0.44	.52	.65

6815 **TEST TUBE BASKETS** for sterilizing in bacteriological work. Each **$0.50**

TEST TUBE BRUSHES. See **BRUSHES, TEST TUBE,** Page **419.**

TEST TUBE CLAMPS. See **CLAMPS, TEST TUBE,** Page **423.**

TEST TUBE RACKS. See **SUPPORTS, TEST TUBE,** Page **486.**



No. 6815

THERMIT REACTION APPARATUS

When the thermit is ignited in one spot, the combustion so started continues throughout the entire mass without supply of heat or power from the outside and produces superheated liquid steel and superheated liquid slag, attaining a temperature of about 4881° F. in less than 30 seconds. The advantage of such a compound in iron and steel welding is at once apparent.

In order that science instructors may demonstarte the properties of such a compound, we offer combination equipments for showing a few fundamental experiments.

6819A **Thermit Welding a Small Piece of Steel to a Steel Plate** . . . . . Complete outfit **$2.45**

6819B **Thermit Burning a Hole through a Steel Plate** . . . . . Complete outfit **21.00**

6819C **Thermit Welding a Large Boss to a Steel Plate** . . . . . Complete outfit **22.25**

6819D **Thermit Used in Pipe Welding** . . . . . Complete outfit **35.00**

6820 **THERMIT COMBINATION OUTFIT.** Includes all material and equipment necessary to perform all four experiments above listed. Shipping weight 270 pounds . . . . . Complete outfit **65.00**

6820A **THERMIT COMBINATION OUTFIT.** Includes all material and equipment necessary to perform experiments of Nos. **6819A to 6819C.** Shipping weight 230 pounds . . . . . Complete outfit **31.00**

6821 **THERMIT, black** . . . . . Per Pound **.50**

6822 **IGNITING MIXTURE** (8 ounces smallest quantity sold) . . . . . Per Pound **1.30**

THERMOMETERS. See Pages **213** to **216.**

THERMO-REGULATORS. See **GAS REGULATORS,** Page **446.**

6955 **THISTLE TUBES**

	a	b	c
Length, inches	10	12	15
Each	$0.08	.12	.15

6825 **TIN FOIL,** regular thickness . . . . . Per Pound **1.25**

No. 6834

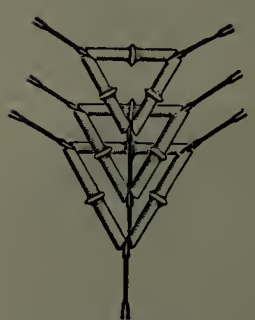
TONGS, CRUCIBLE. See **CRUCIBLE TONGS.**

6830 TRAYS, GLASS (Photo Trays), crystal glass.

	a	b	c
Size, inches	4 × 6	5½ × 8½	8 × 10½
Each	**$0.22**	**.27**	**.55**

6834 TRAYS, FUSED SILICA, rectangular. (See index, "Fused Silica Ware," for characteristics.)

	a	b	c	d	e	f	g	h
Length, outside, inches	6⅛	9¼	10	12¾	14	15¾	16¾	16¾
Width, outside, inches	3¾	2⅝	7	6	4⅝	9½	11¼	13⅜
Depth, outside, inches	⅞	1	⅞	1⅜	1	1½	1½	1¾
Each	**$2.00**	**2.25**	**3.25**	**3.50**	**3.50**	**4.25**	**5.75**	**7.00**



Nos. 6840a–c

6840 TRIANGLES, "PIPE STEM," iron wire, covered with porcelain, raised centers.

	a	b	c
	Small	Medium	Large
Length of side, inside, inches	2¾	3	3¼
Each	**$0.08**	**.08**	**.08**

TRIANGLES, PLATINUM. See **PLATINUM WARE,** Page **473.**

No. 6842 No. 6843

6842 TRIANGLES, FUSED SILICA (Silica Tubes on Iron Wire). (See index, "Fused Silica Ware," for characteristics.) Will outwear innumerable pipe-stem triangles.

	a	b	c	d	e	f	g	h	i	j	k
Length, inches	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4
Each	**$0.13**	**.13**	**.13**	**.16**	**.16**	**.20**	**.20**	**.25**	**.25**	**.30**	**.30**

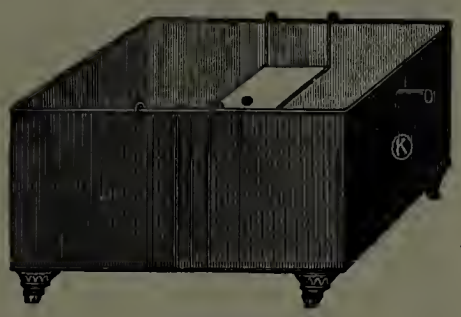
6843 TRIANGLES, FUSED SILICA (All Silica Tubes). (See index, "Fused Silica Ware," for characteristics.)

	a	b	c	d	e	f	g	h	i	j	k
Length, inches	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4
Each	**$0.75**	**.75**	**.75**	**.90**	**.90**	**1.00**	**1.00**	**1.00**	**1.15**	**1.15**	**1.25**

No. 6850

No. 6852

No. 6855



No. 6860b

6850 **TRIPOD, japanned iron,** 8 inches high. Inside diameter of ring 3½ inches, with three legs **$0.28**

6852 **TRIPODS, japanned iron,** 8 inches high.

	a	b	c	d	e
Inside diameter, inches	3	4½	6	8	10
Outside diameter, inches	5	6	8	10	12
Each	**$0.35**	**.45**	**.55**	**.70**	**.86**

6855 **TRIPODS, CONCENTRIC RINGS, japanned iron,** 8 inches high. Diameters given are outside measurements of largest ring.

	a	b	c	d	e
No. of Rings	2	3	4	5	6
Diameter, inches	5	6	8	10	12
Set	**$0.48**	**.64**	**.84**	**1.20**	**1.60**

6860 **TROUGHS, PNEUMATIC,** heavy gauge metal, each size with sliding shelf and overflow tube.

	a	b	c
Length, inches	9	12	14⅜
Width, inches	6¼	9	8½
Depth, inches	3⅝	5	5
Each	**$1.30**	**1.50**	**2.20**

6862 **TROUGH, PNEUMATIC,** of porcelain **1.15**

6868 **TUBING, FUSED SILICA COMBUSTION.** (See index, "Fused Silica Ware," for characteristics.) Fused Silica Combustion Tubes are largely employed in electric resistance furnaces for the determination of carbon, oxygen, and sulphur in iron, steel and other non-volatile metals; for the determination of sulphur in pyrites cinder, and for the determination of carbon, hydrogen, halogens and sulphur in organic compounds.

The superior heat and chemical resisting properties of Fused Silica have led to the general adoption of tubes of this material to replace glass, porcelain and platinum in combustion work.

	a	b	c	d	e	f	g
Bore, mm.	1–2	3	4–5	6–7	8	9–10	11
Thickness of Wall, mm.	.5–3	.5–2.5	.5–2	.5–2	.5–2	1–2	1–2
Price per Foot	**$0.25**	**.45**	**.75**	**.90**	**1.10**	**1.50**	**1.40**
Extra Price per tube for Closed End	**$0.10**	**.15**	**.20**	**.20**	**.20**	**.25**	**.25**

	h	i	j	k	l	m	n
Bore, mm.	12–13	14	15–16	17–18	19	22	25
Thickness of Wall, mm.	1–2	1–2.5	1–2.5	1–2.5	1–3	1–3	1–3
Price per Foot	**$1.50**	**1.60**	**1.75**	**1.90**	**2.10**	**2.30**	**2.50**
Extra Price per Tube for Closed End	**$0.25**	**.35**	**.35**	**.50**	**.50**	**.65**	**.75**

6872 **TUBES, ABSORPTION, Bunsen's,** graduated to 180 millimeters **$0.75**

6873 **TUBES, ABSORPTION, Bunsen's,** with Bulb. Graduated to 170 millimeters **1.00**

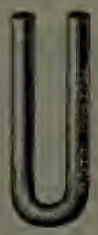
6875 **TUBES, ARSENIC,** hard glass.

a	b	c	d
$0.06	**.06**	**.06**	**.06**

Set of Four . . . . . **.22**

No. 6872 No. 6873

No. 6920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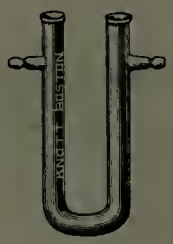
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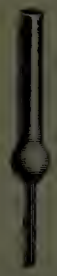
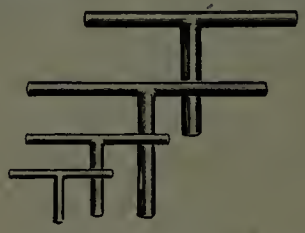


No. 6887 No. 6888

No. 6900


Nos. 6906a–d

No. 6902

No. 6904

Nos. 6908a–d

No. 6910

No. 6911

6880 TUBES, CALCIUM CHLORIDE, U-Shape, Plain.

	a	b	c	d
Size, inches	3 × ¾	4 × ¾	5½ × ¾	6 × ¾
Each	$0.14	.16	.18	.20

6882 TUBE, CALCIUM CHLORIDE, 6 inches long, designed to lay flat on the table. A most convenient and useful type $0.48

6884 TUBES, CALCIUM CHLORIDE, U-SHAPE, with side tubes.

	a	b	c
Size, inches	4 × ¾	6 × ¾	8 × ¾
Each	$0.25	.32	.50

6887 TUBES, CALCIUM CHLORIDE, straight with one bulb.

	a	b	c
Size, inches	4 × ¾	6 × ¾	8 × ¾
Each	$0.10	.14	.16

6888 TUBES, CALCIUM CHLORIDE, straight with two bulbs.

	a	b	c
	Small	Medium	Large
Size, inches	4 × ¾	6 × ¾	8 × ¾
Each	$0.10	.15	.18

6890 TUBES, CALCIUM CHLORIDE, Marchard's.

	a	b
Size, inches	4 × ¾	6 × ¾
Each	$0.25	.33

6895 TUBE, CHLORINE, after Newell's "Descriptive Chemistry" (Experiment 23) $0.77

6900 TUBES, CONNECTING, BRASS, for reducing from 7/16 to 9/32 inch 15

6902 TUBES, CONNECTING, BRASS, T Shape.

	a	b	c
Diameter, inch	5/16	3/8	½
Each	$0.27	.32	.40

6904 TUBES, CONNECTING, BRASS, Y Shape.

	a	b	c
Diameter, inch	5/16	3/8	½
Each	$0.27	.32	.40

6906 TUBES, CONNECTING, GLASS, T Shape.

	a	b	c	d
Diameter, inch	¼	5/16	3/8	½
Each	$0.08	.10	.13	.16

6908 TUBES, CONNECTING, GLASS, Y Shape.

	a	b	c	d
Diameter, inch	¼	5/16	3/8	½
Each	$0.08	.10	.13	.16

6910 TUBE, CONNECTING, LEAD, Y Shape, ¼ inch $0.22

6911 TUBE, CONNECTING, WHITE METAL, Y Shape, for 3/8-inch rubber tubing 25

6920 TUBES, CULTURE, of medium heavy glass, round bottom, no lip.

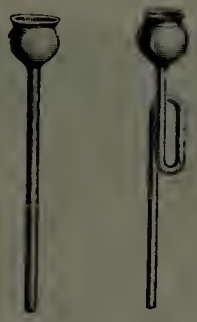
	a	b	c
Size, inches	4 × ½	5 × 5/8	6 × ¾
Per Dozen	$0.24	.32	.40

TUBES, DISTILLING, see **DISTILLING TUBES,** Page 435.

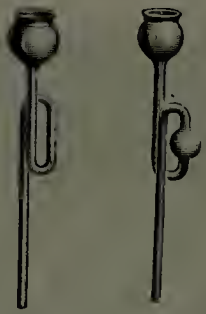
No. 6925

No. 6923

Nos. 6935a–c



No. 6955



No. 6952

No. 6950

No. 6960

No. 5620b

6923 **TUBE, FERMENTATION,** with graduated test tube. (Dr. Einhorn's Saccharometer.)
With directions **$0.75**

6925 **TUBES, FERMENTATION,** ungraduated, on foot.

	a	b
Length, inches	5¾	6¾
Diameter, inch	½	⅝
Each	**$0.27**	**.33**

6930 **TUBES, FILTER (CARBON FILTERS).** Stems ground to a point.

	a	b	c
Diameter of Top, mm.	25	30	35
Each	**$0.24**	**.55**	**.64**

5620 **TUBES, GAS,** for collecting gases over mercury.

	a	b
Capacity, cc.	50	100
Subdivided, cc.	⅕	⅕
Each	**$1.45**	**1.80**

6935 **TUBES, IGNITION,** ordinary hard glass.

	a	b	c
Length, inches	4	6	8
Diameter, inch	½	⅝	1
Each	**$0.05**	**.07**	**.14**

6938 **TUBES, IGNITION,** of superior quality hard glass, best for generating oxygen.

	a	b	c
Length, inches	4	6	8
Diameter, inch	½	⅝	1
Each	**$0.12**	**.16**	**.32**

No. 6945

6945 **TUBES, NESSLER'S,** for ammonia tests in water analyses; of colorless glass.

	a	b	c
Graduated, cc.	50	100	50 & 100
Each	**$0.65**	**.80**	**.95**

6950 **TUBE, SAFETY, thistle top,** one bulb in bend, length 12 inches **$0.17**

6952 **TUBE, SAFETY, thistle top,** bend in stem. Length 12 inches . . . . . **.22**

TUBES, SPECIMEN. See **VIALS,** Page **492.**

6955 **TUBES, THISTLE.**

	a	b	c
Length, inches	10	12	15
Each	**$0.08**	**.12**	**.15**

6960 **TUBE, VINEGAR,** Massachusetts Board of Health, for determining the percentage of alcohol . . . **$0.45**

Nos. 6970 and 6971

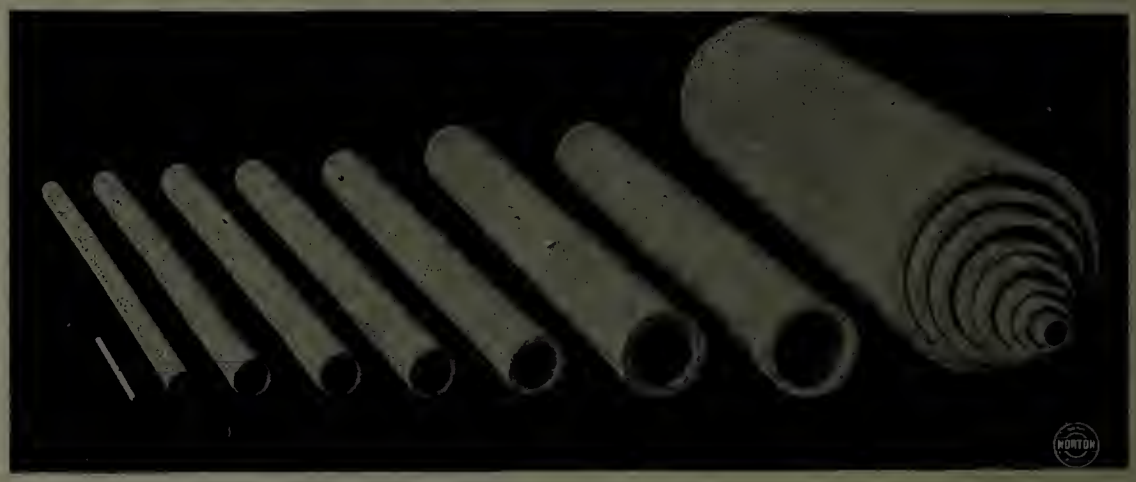
6970 **TUBING, GLASS,** best quality, free from lead, especially adapted for glass blowing and bending, usual wall for chemical laboratory purposes. The following sizes are carried in stock, — 4, 5, 5½, 6, 6½, 7, 8, 9, 10, 12, 15, 18, 20, 22, and 25 millimeters outside diameters . . . . . Per Pound **$0.54**

6971 **TUBING, GLASS,** same as above in quality, but larger in diameter. The following sizes are carried in stock, — 30, 35 and 40 millimeters outside diameter . . . . . Per Pound **.65**

NOTE. — **In ordering Glass Tubing, always specify the diameter desired.**

6973 **TUBING, GLASS CAPILLARY,** outside diameter 6–7millimeters, bore ½, 1 and 1½ millimeters. (In ordering specify bore desired.) . . . . . Per Pound **.75**

6975 **TUBING, GLASS BAROMETER,** outside diameter 8–9 millimeters, bore 3 millimeters Per Pound **.75**



Nos. 6977 to 6979

6977 TUBING, ALUNDUM (See Index, **"Alundum Ware,"** for characteristics). Length 12 inches.

	a	b	c	d
Bore, inch	1/2	5/8	3/4	1
Wall, inch	1/8	1/8	1/8	1/8
Each	**$2.25**	**2.25**	**2.35**	**2.50**

6978 ——, length 18 inches.

	a	b	c	d
Bore, inch	1/2	5/8	3/4	1
Wall, inch	1/8	1/8	1/8	1/8
Each	**$3.60**	**3.60**	**3.75**	**3.90**

6979 ——, length 24 inches.

	a	b	c	d
Bore, inch	1/2	5/8	3/4	1
Thickness, inch	1/8	1/8	1/8	1/8
Each	**$5.00**	**5.00**	**5.20**	**5.35**

NOTE. — Alundum Tubes up to 10-inch bore by 1/2-inch wall can be obtained. Prices on application. A charge of 10 per cent. additional to above prices will be made for closing one end of the tube.

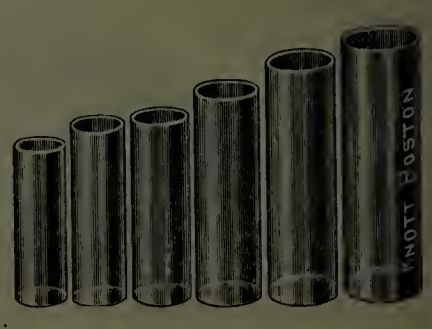
6982 TUBING, GLASS COMBUSTION, of hard glass, melting point 800° C. Outside diameter 8, 10, 13, 19 and 25 millimeters. (In ordering specify sizes desired) . . . . . Per Pound **$1.35**

6984 TUBING, PORCELAIN COMBUSTION. Glazed inside and outside. Will stand a temperature of 1800 degrees Fahrenheit and is practically gas tight. In 24-inch lengths.

	a	b	c	d	e	f
Diameter, inch	3/8	5/8	3/4	1	1 1/8	1 1/4
Per length	**$1.80**	**2.20**	**2.50**	**3.00**	**3.60**	**4.20**

6990 TUMERIC PAPER . . . . . Per Sheet **$0.04**
Per Quire **.66**

No. 7075



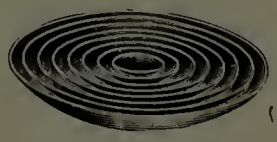
Nos. 7080a-f

7075 VASCULUM OR COLLECTING CASE, of metal, with leather shoulder straps. Size 18 × 6 1/2 × 4 1/2 inches **$1.75**

7080 VIALS, Shell Vials, round, straight wall, for use with corks.

	a	b	c	d	e	f
Capacity, drams	1	2	3	4	6	8
Height, mm.	45	55	60	65	70	75
Diameter, mm.	15	17	19	21	23	25
Per Dozen	**$0.12**	**.15**	**.18**	**.20**	**.30**	**.40**

No. 7085



Nos. 7095a-i

No. 7100

7085 **VISCOSIMETER, SCOTT'S,** for determining the viscosity of oils, etc. A reliable instrument comparing very favorably with those of much higher price **$14.25**

7090 **VISES for laboratory use,** with hardened anvil and jaws.

	a	b
Length of Jaw, inches	1½	2
Jaws open, inches	2	2½
Dimensions of Anvil	¾ × 1	1 × 1¼
Each	**$0.65**	**.95**

VOLUMETRIC FLASK. See **FLASKS, VOLUMETRIC.**

WARMING TABLE. See Page **466.**

WASHING BOTTLES. See **BOTTLES,** Page **418.**

7095 **WATCH GLASSES,** thin and well annealed.

	a	b	c	d	e	f	g	h	i
Diameter, inches	1	1½	2	2½	3	3½	4	5	6
Per Dozen	**$0.18**	**.20**	**.25**	**.48**	**.54**	**.75**	**.88**	**1.50**	**2.50**

7100 **WATCH GLASSES, SYRACUSE,** designed so that one may be placed above another; outside diameter 70 mm., inside diameter 53 mm. . . . . Per Dozen **$0.60**

7110 **WATCH SPRINGS** . . . . . Per Dozen **.20**

7115 **WAX, SEALING,** in sticks . . . . . Per Pound **.44**

7120 **WAX TAPERS** . . . . . Per Box **$0.10**

WEIGHTS. See pages **58** to **63.**
WICKS for Alcohol Lamps. See Page **452.**
WIRE, all kinds. See pages **311** to **313.**
WIRE GAUZE. See page **446.**

60–80 **WATER HEATER WITH BURNER.** Will heat water to boiling point in three minutes. Consists of a solid flame burner on which is placed the water heater. This heater consists of a coil of copper tubing encased in a finished metal casting. The cold water enters this heating tube and by regulating flow of water and height of flame, the issuing water may be obtained either boiling, hot, warm or cold. Total height 9 inches. With Burner, complete **$9.50**

60–81 **WATER HEATER** only, same as above but without burner **6.60**

WATER HEATER, ELECTRIC. See **ELECTRIC APPLIANCES,** Page **436.**

No. 60–80

ALUNDUM WARE

Alundum is fused aluminum oxide. When bonded with ceramic materials and given proper heat treatment, refractory articles can be obtained that have many desirable properties. Pure alundum, which is more than 99 per cent. aluminum oxide, **melts at 2050° C.** and the bonded shapes at temperatures somewhat less than this depending on the character of the mixtures.

Alundum is **a very inert substance** and the bonded articles are not readily attacked by chemically active solutions.

Alundum is a poor **conductor of electricity** and is, therefore, particularly valuable in electrical constructions.

PROPERTIES.

Coefficient of Expansion — 0.0000071 per degree C.

Specific Electrical Resistance.

130	megohms	at	528°	Centigrade
16	"	"	730°	"
5.3	"	"	892°	"
1.8	"	"	1020°	"

Porosity: — Three mixtures may be obtained, — 36 .9 per cent., 40.7 per cent. and 47.4 per cent. We carry in stock mixtures of 40.7 per cent. porosity.

Filter Cones have special mixtures and may be specified as dense, medium or coarse. We carry in stock a mixture giving the medium porosity.

All Filter Discs have a porosity of 43.9 per cent.

Alundum articles listed in this catalogue are carried in stock for immediate shipment. Muffles, other articles, and special pieces can be obtained. We should be most pleased to correspond regarding special needs.

"PYREX" GLASSWARE

"PYREX" Glassware was recently developed in this country and holds promise of still greater extensive use than at present.

1. It contains no heavy metals nor metals of the magnesium — lime — zinc group.
2. Under numerous tests for determining stability in comparison with best other glasses "Pyrex" Glassware has proved greatly superior.
3. "Pyrex" Glassware does not commence to soften below 800° C. and a rod heated to 300° C. and then plunged into cold water will not break.
4. Its chief characteristic is that of thick walls, a construction made possible by the very low expansion coefficient of 0.0000032 (porcelain has an expansion coefficient of 0.0000036). This characteristic greatly increases the durability of the vessels without diminishing the resistance to sudden heating and cooling.

Our stock of **"PYREX"** Glassware as listed through this catalogue is complete. We offer it as resistance ware well comparable with Jena Glassware that cannot now be obtained.

FUSED SILICA WARE

The unusual properties of Pure Fused Silica Ware make it suitable for most analyses where platinum has heretofore been necessary. These properties are:

1. Its melting point is above 1500° C.
2. Its coefficient of expansion is extremely small being .00000059, which is about $\frac{1}{17}$th that of glass. Crucibles or other dishes may be heated to red heat and then plunged into cold water without cracking or breaking.
3. It is not attacked by acids.
4. It is absolutely constant in weight.
5. It is insoluble in water.

On account of the increased cost of platinum the various laboratory vessels and utensils listed in this catalogue may profitably receive the careful consideration of every chemist.

ROYAL WORCESTER PORCELAIN WARE

Royal Worcester Porcelain Ware has been most carefully tested to ascertain its suitability for laboratory use in comparison with similar ware so readily obtained before the European War.

The National Physical Laboratory of Teddington, England, has directed tests to ascertain

1. The Effect of Chemical Reagents.
2. The Behavior of the Glaze at High Temperatures.
3. Constancy of the Weight of the Ware.
4. Resistance to Sudden Changes of Temperature.

1. THE EFFECT OF CHEMICAL REAGENTS.

(a) Strong Sulphuric Acid.

After a four-hour test the acid acting on 209 square centimeters a dish gained 0.0016 gram, — (a gain of 0.0008 gram per 100 square centimeters.

(b) 10 per cent. Solution Caustic Soda at 90°-100° C. (Concentration of solution by evaporation prevented by conducting the experiment in a closed oven.)

After a four-hour test, the caustic soda solution acting on 209 square centimeters, a dish lost in weight -0.0308 gram, — a loss of 0.0147 gram per 100 square centimeters.

(c) 10 per cent. Solution Sodium Carbonate at 90°-100° C. (Concentration of the solution by evaporation prevented by conducting the experiment in a closed oven.)

After a four-hour test, the sodium carbonate acting on 209 square centimeters, a dish lost in weight -0.0018 gram, — a loss of 0.0009 gram per 100 square centimeters.

2. BEHAVIOR OF THE GLAZE AT HIGH TEMPERATURES.

(a) A few broken pieces of Royal Worcester Porcelain were placed in a Royal Worcester Porcelain Dish and heated for four hours in a large gas muffle the temperature of which was kept constant at 1000° C.

Fragments of porcelain adhered to the dish but were readily removed by slight pressure of the fingers, but the glaze of the dish was but slightly affected. The dish was not at all discolored and the brightness of the glaze was not appreciably dimmed.

3. CONSTANCY OF THE WEIGHT.

(a) A dish weighing 22 grams was first gently heated, cooled and weighed. It was then heated for one and one-half hours in a muffle at a temperature of 850° C.

After cooling the dish showed a loss of but 0.0002 gram.

4. RESISTANCE TO SUDDEN CHANGES OF TEMPERATURE.

(a) A dish was first filled with wax which was melted and heated gradually to a temperature of 160° C. It was then allowed to cool to 150° C. to secure that the temperature of the dish was equal to that of the wax.

The dish, when plunged with contents into water at 15°, remained unbroken.

This treatment was continued in a similar way at successively higher temperatures up to 230° C., the dish remaining intact.

(b) A dish was heated in a muffle at a temperature of 850° C. It was then removed with a thick pair of cold iron tongs and placed on a cold stone bench to cool.

No cracking or chipping even of the glaze was observed.

As a result of these tests, we ordered a sample line of this ware and have had it tested by men of the highest reputation in this country. Their reports enable us to recommend this ware, confident that it in every way meets the most exacting demands of Chemists.

NATIONAL LOOSE-LEAF NOTE-BOOKS

BIOLOGY — CHEMISTRY

By Arthur S. Dewing, Ph.D.

The effort has been to prepare these laboratory instructions in a manner to give students only such assistance as will enable them to observe and think for themselves. The author has avoided most carefully the "Verification Method" of teaching science by which the student is told exactly what he is to find or what conclusion to draw. The pupil is guided right to follow an individual channel in constructive observation and from a suggested sequence of thought learns to observe accurately and think clearly.

The Loose-leaf System has long been recognized as one that affords the greatest latitude for choice and one that is best adapted to individual requirements. A teacher is enabled to select from a series of experiments greater than required, the experiments adapted particularly to individual conditions. One may select a series adapted to meet State requirements, local educational requirements, etc., etc. We have endeavored to keep in file courses of laboratory instruction satisfactorily meeting in actual use the many requirements. We should be pleased, therefore, to send, upon request, a note-book containing a series of direction sheets in Chemistry, Biology or Physics (See page 27) outlining a course found entirely adequate in meeting similar requirements. Such service is entirely gratis.

NATIONAL BIOLOGY DIRECTION SHEETS

This series covers Botany, Zoology and Physiology, 118 sheets. A number of these direction sheets are in the nature of introductory exercises concerning the general nature of organisms and their simple chemical processes and they should, when possible, precede the work in any of the special exercises. Larger amounts of matter are given in every case than can ordinarily be undertaken, the author believing that a variety of conditions requires a variety of methods and subjects.

A FEW NOTES AND COMMENTS

Wallace, Idaho, Independent School District No. 8.

"I believe the use of your books will do more to standardize science work than anything else; at the same time they allow for a teacher's preference and originality by providing a choice of sheets. As I am myself using the Biology Set, I sball make quite a point of that to illustrate the system."

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"I find the Note-Book very interesting and full of practical usefulness."

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"I am using the Note-Book in my class and find it most satisfactory."

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"I have been using your National Note-Books in Botany and Physics this year, and wish to express to you my complete satisfaction in regard to same. This has been my idea of a note-book for many years, but have never before found one so well selected and arranged, so reasonable in price and so neatly put up and constructed, as tbe ones secured from you."

"They are tbe best I know of and shall not only use them myself, but expect to speak of tbem to all who teach science, with whom I come in contact."

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"The sheets of the National Biology Note-Book are in use in this school and I am glad to say that tbey are a great help in that subject. We also use the National Physics Note-Book and find it very practicable. I thank you for your interest and your attempt to supply so many good things tbat scbools want."

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"I have examined with interest the Loose-Leaf Note-Book for Biology whicb you sent us. It seems to be an excellent plan. There has been a very wise selection of the essentials. I shall take pleasure in recommending this to teacbers."

NATIONAL CHEMISTRY DIRECTION SHEETS

The National Chemistry Direction Sheets were prepared to meet several demands. In the first place the experiments, exercises, and descriptive matter, when taken together, and in the order indicated by the Index, supply a clearly defined method for teaching Chemistry. Its spirit is to develop the powers of observation and inference. The series covers 148 sheets from which number the teacher is enabled to select a course adapted to individual need.

A FEW NOTES AND COMMENTS

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"The work done in my Chemistry class this year has been much simplified by the use of your Chemistry Loose-Leaf Notes. With a proper amount of selection of the notes I find I have been able to accomplish tbe laboratory work in less time than usual and, I think, with more satisfactory results."

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"I believe that by a proper use of the Notes, a good course could be given in any school, using specially adapted experiments and your notes in place of any regular text."

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"You are at liberty to use anytbing that I have written commendatory of the Loose-Leaf Note-Books. I think tbey are the ideal plan for teaching Chemistry in the laboratory, and when accompanied by efficient supervision of the students at work, by study from a well-digested text-book, and by discussion in tbe classroom, and all summed up by the teacher in a weekly lecture with demonstrative experiments, the course could not, in my opinion, be surpassed."

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"I find both the Chemistry and Physics Sheets the most complete and most satisfactory that I have ever seen. You may expect future orders from our school."

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"The National Pbysics and Chemistry Sheets are giving eminent satisfaction. I shall use them exclusively next year."

Barboursville, Ky., Union College.

"We are using both your Physics and Chemistry Note-Books in our work at Union College and you will doubtless be gratified to know that we are highly pleased with them. They are thoroughly practical for laboratory use."

Wilmington, Delaware, High School.

"I have used your National Physics Note-Books for nine years and your Chemistry about seven years and I like them so much that I would like to introduce tbe National Botany-Biology and Physiology in our classes."

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Methylene Blue Borax (Unna)	.50	1.05	
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